THE

FIFTH ANNUAL REPORT

OF THE

AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION,

IN CONVENTION AT

BOSTON, JUNE 11th, 12th, and 13th,

1872.

CINCINNATI:
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AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION,

OFFICERS FOR 1872:

H. M. BRITTON, of Cincinnati, - - - -	President.
N. E. CHAPMAN, of Cleveland, - - - - - -	1st Vice-President.
J. B. PENDLETON, of Portsmouth, Va , - -	2d Vice-President.
S. J. HAYES, of Chicago, - - - - - - - -	Treasurer.
J. H. SETCHEL, of Cincinnati, - - - - -	Secretary.

REPORT.

The Fifth Annual Session of the American Railway Master Mechanics' Association convened at Horticultural Hall, Boston, June 11th, 1872.

Officers Present.

H. M. BRITTON, Supt. White Water Valley R. R.....PRESIDENT.
... and Pittsburgh R. R.....1ST VICE-PRESIDENT.
... Central R. R. ....TREASURER.
... R. R.........................SECRETARY.

With the Compliments of the
... Railway Master Mechanics'
ASSOCIATION.
..., Secretary,
Cincinnati, ...

... at 9:30 A. M., by the President, and ... House, of Boston.

... in order will be to receive the minutes ... printed in pamphlet form, which would ... our pleasure that they be approved with-

... the Rome, Watertown & Ogdensburgh ... minutes, as printed, be approved without

... ness in order is the calling of the roll. ... to the calling of the roll, and answer to

Mr. Eddy, ... Albany Railroad—Perhaps our roll would be a little fuller if we gave ... here a chance to become members who are not, previous to the calling of the roll.

The President—Mr. Eddy, the next business in order is signing the Constitution. We want to see who of the old members are present, first.

The roll was then called, and the following members answered to their names:

lee; they therefore considered it best to meet on the 11th of Jun I hope this change has not inconvenienced any member.

Some of our members who live in the cold sections have informe me that they think May rather early to hold our annual meetin After a very cold winter they find it difficult to leave their busine long enough to attend our meeting. It would be well to select th place of holding our next meeting early in the session, and then de termine on the time of holding it which will suit the members bes

Great credit is due the various committees for the excellent repor which they presented at our last annual meeting, which your Com mittee on Printing have had printed in pamphlet form. Your Se retary has mailed a copy to each member, and to the officers railroads, as far as he has known their addresses.

A number of the Third and Fourth Annual Reports are still o hand, and will be supplied to members on application either person ally or by letter.

By having the First and Second Annual Reports reprinted—wit which few of the members are supplied—it will be possible for thos who wish to do so to preserve the series complete and have the bound in one volume.

It is thought that the reports of your committees have been th means of diffusing much valuable information to those engaged i operating and constructing railroad machinery, and that the pla which you have adopted of collecting and recording the experienc and knowledge of those engaged in the same occupation in differen parts of the country may be extended very much farther, and tha the system of transacting business which you have adopted has bee much more successful than was expected by those who organized i

I would recommend that a committee be selected early in the se sion to present to this convention subjects for our consideration the next annual meeting, so that there may be ample time for ap pointing the committees before we adjourn. In some cases membe can not serve on committees. If they are appointed late in the se sion—which has been our custom—no time is given to appoint othe in their place until some days after we adjourn, which often detain the committees in beginning their work.

Mr. Perry, of the Cheshire Railroad, was appointed Chairman

the Committee on Tires at our last meeting, although he was not present. As soon as he was notified of his appointment, however, he requested to be excused from serving on account of business. His request was complied with, and Mr. Lauder, of the Northern Railroad, appointed in his place. The time was then so short that they feared they could not prepare a report for this meeting. Should the Convention wish to continue this committee, we may look for a long and interesting report at our next meeting.

Boiler explosions are becoming quite frequent. Scarcely a day passes but we hear of one or more. A very small percentage of these are locomotive boilers, yet enough to show us the necessity of using every care possible in their construction and use.

I think a commission has been appointed by Congress to experiment for the purpose of determining certain rules for the construction of boilers. If such a commission has been appointed I would recommend that this Convention send a committee to be present at such experiments as may be made, and gather all the information possible, and report at our next meeting.

Since our last meeting the duties of your Secretary have been quite arduous, requiring him to obtain help. I am happy to say the duties of his office have been attended to in the best manner possible. I congratulate the Association for selecting Mr. Setchel for this important office, and trust he may be induced to serve another year.

I would especially urge upon all members the importance of discussion. After the various reports have been presented to the Convention there should be a free interchange of opinions. Our Association is intended for the purpose of investigating all matters connected with railway machinery.

So long as master mechanics have as much human nature in them as most of them now display, there will be differences of opinion; let us, however, trust that each and every one will aim chiefly to learn the most effective and economical manner of constructing and working railroad machinery.

The committees will, doubtless, present reports which will contain valuable facts and information, but should any member hold different views from those advanced by the committees, or should his experience suggest any modification or addition to their conclusions,

I trust he will so state it to this Convention; by so doing we wil arrive at facts that can be reached in no other way.

Much has been said about the hospitality extended to us by ou friends at our meetings. It is pleasant to know that we have friend who thus manifest their good feelings to us in the cities where w hold our conventions, yet we should be careful not to accept any thing that will cast a shadow on the reputation of our institution There is much to interest us in and about this great city, and whicl may tend to take the members away from our sessions. Our by laws specify that one session shall be held each day, from 9 A. M till 2 P. M. I hope each member will so arrange as to devote hi time to the Convention each day while it lasts, thus enabling us t dispatch the business satisfactorily, which can not be done if th members are absent.

Such committees as are not ready to report will confer a favor b making it known before their reports are called for.

Gentlemen, I have served you since the organization of our Asso ciation, in 1868, as your President. I have endeavored to do so t the best of my ability; but, feeling that there are many member better qualified for the position, it is but fair, and I request you, t select a successor at our election of officers.

Thanking you for the many acts of kindness shown me since th formation of this Association, again I thank you for your attentio while I have been making these few imperfect remarks.

To you as a body I now commit this Convention.

The Treasurer's Report was then read by the Secretary.

JUNE 11, 1872.

S. J. HAYES, Treasurer, in Account with

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

SEPTEMBER, 1871, TO JUNE 1872.	Dr.	SEPTEMBER, 1871, TO JUNE, 1872.	Cr.
To Receipts and Assessments to date	$1,449 00	By Balance due Treasurer as per last account	$254 85
" W. W. Evans, contributions	20 00	" H. M. Britton, Voucher No. 1	18 00
" A. P. Burroughs, Initiation Fee	1 00	" M. E. Jones " " 2	40 00
		" L. P. Dodge " " 3	10 00
		" L. P. Dodge " " 4	15 50
		" L. P. Dodge " " 5	500 00
		" J. E. Pettibone " " 6	2 50
		" Bosworth, Chase & H " " 7	14 00
		" D A. Cashman " " 8	7 00
		" Wilstach, Baldwin & Co " " 9	3 50
		" Wilstach, Baldwin & Co " " 10	149 00
		" Wilstach, Baldwin & Co " " 11	337 50
		" S. J. Hays " " 12	6 00
		" Wilstach, Baldwin & Co " " 13	12 50
		" J. H. Setchel, on account " " 14	21 00
		" S. J. Hayes " " 15	20 00
		" Balance on hand	58 65
	$1,470 00		
June 11th, to Balance on hand	$58 65		$1,470 00

Respectfully submitted, S. J. HAYES, TREASURER,

APPROVED:

H. M. BRITTON,
JAS. SEDGLEY,
MORRIS SELLERS, } *Finance Committee.*

On motion, it was voted that it be received.

THE PRESIDENT—Before proceeding with the reports of committees, there is some correspondence that I would recommend that the Convention hear read and act upon; and some, perhaps, which it would be well to refer to a Committee on Correspondence. A letter has been received from the Secretary of the Superintendents' Association of this city, which, perhaps, it would be well to have some action taken upon, some committee appointed, or otherwise, as the Convention thinks proper, before we proceed to other business. If there is no objection the Secretary will read it.

BOSTON, May 22, 1872.

MR. THOMPSON, *Chairman of Committee of Master Mechanics' Association*, East Boston:

DEAR SIR—At a meeting this day of the Superintendents of Boston, it was unanimously

Voted, That the Secretary notify the Chairman of the Committee of the Master Mechanics' Association that the Boston Superintendent's Association hereby extend a hearty welcome to the members of the Master Mechanics' Association, and offer them a special free train over their respective roads to such points as they may wish to visit while here.

Voted, That the Superintendents will cheerfully co-operate with said Chairman of the Committee, or with any Committee the Master Mechanics' Association may appoint, in carrying out any arrangements that will contribute to the profit and pleasure of the members of the Association.

Very truly yours,

A. FIRTH, *Sec'y*.

On motion of Mr. Wells, of the Jeffersonville, Madison & Indianapolis Railroad, it was voted that it be received and a vote of thanks be tendered to the parties for their kindness.

THE PRESIDENT—There have been several letters received from individuals extending invitations, etc. Is it your pleasure that they be read or referred to a Committee on Correspondence?

On motion of Mr. Hayes, of the Illinois Central Railroad, it was voted that they be referred to a Committee on Correspondence; also, that such committee consist of five members to be appointed by the Chair.

The President announced the committee as follows: Messrs. Hayes, of the Illinois Central Railroad; Robinson, of the Great Western Railroad; Hill, of

the Erie Railway; Ham, late of the New York Central Railroad; and DeClercq, of the Toledo, Peoria & Warsaw Railway.

The President—The next business in order will be the report of your Committee on Boiler and Boiler Materials, consisting of Messrs. Hayes, Illinois Central Railroad; Jauriet, Chicago, Burlington & Quincy Railroad; and Lamb, Des Moines Valley Railroad.

REPORT ON BOILERS AND BOILER MATERIAL.

To the American Railway Master Mechanics' Association:

Gentlemen—Your Committee on Boilers and Boiler Material beg leave to submit the following report:

Copies of the following questions were sent to the various master mechanics, and twenty-four answers were received:

1st. Is the present form of locomotive furnace the proper one for the economical consumption of coal, or can you suggest a different and better form?

2d. Please give your views of the comparative merits of the plain furnace, as compared with that having the fire-brick arch or water-table.

3d. What, in your opinion, are the comparative merits of straight and wagon-top boilers for locomotives? of boilers with one, compared with those having two domes? of taking steam in the dome or domes, compared with the use of a perforated dry-pipe? Please state your preferences, with your reasons therefor.

4th. What diameter of flues do you advise for use in wood and coal-burning engines?

5th. Have you ever experimented with a view to burning bituminous coal with a draft from the top of the fire downwards? If you have, please state the results.

6th. Do you know of an American iron for furnace sheets as free from lamination and liability to blister, as the Low Moor iron? If yes, please state the brand and the length of service of the sheets.

7th. Have you experimented with a view to determining the relative strength of drilled and punched boiler-plate in the rivet seams?

8th. Do you advise drilling instead punching the rivet holes in boiler plate?

9th. Do you think the use of a drift materially lessens the strength of boilers in the rivet seams?

10th. Please state the material and thickness of the thinnest front and back flue sheets you have used with safety in boilers of coal-burning locomotives.

11th. Can you suggest any advantageous changes in material or the construction of locomotive boilers?

12th. For the benefit of the Convention, please communicate any facts or information you have of interest, pertaining to the subject upon which this Committee is required to report.

In reply to the first and second questions, various opinions are expressed. The large majority are in favor of the plain box for wood or coal-burning engines. The reasons assigned are that water tables and brick arches are expensive, and show no economy in fuel used. Your Committee have made no new experiments and can only present you with the views of a few gentlemen—some in favor of plain furnaces, others in favor of the arch or water table for coal-burning engines.

Mr. H. A. Towne, of the Hannibal & St. Joseph Railroad gives results of experiments running through eight months, with engines having plain furnaces, and also the results obtained from the same engines during eight months' service with the water table. The average miles per ton of coal with the plain box is stated at 24.9 and the average with the water table 40.29 miles, a difference of 61 per cent. in favor of the water table.

Mr. Ham, of the New York Central Railroad, states that he has experimented with the plain box, as compared with the brick arch and the water table, and finds a saving of 8 per cent. from the use of the arch, and 12 per cent. from the use of the water table.

Mr. Van Vechten, of the Atlantic & Great Western Railroad states that in his experience "the first cost of the plain box is less it is easier kept in repair, and affords greater economy in fuel" than a box having the arch or water table.

Mr. Setchel, of the Little Miami Railroad, is of the opinion that the plain box will give the best results, all things being considered. He states it as his belief that more fuel can be saved "by a judicious system of firing than by any device that has yet been invented for the consumption of smoke." He says further, and we quote from his letter, "the truth of the matter is this: two-thirds of the locomotives burning coal really burn more than they should, for the reason that the locomotive attendants are not particularly interested in the amount of fuel saved, and do not give the matter the attention it deserves, and hence it is that any man who has had practice, and who has given the subject a sufficient amount of study to get up a plausible theory for a successful furnace, almost invariably succeeds in making a show of a saving of coal, simply by giving close attention to the firing, when perhaps, with the same attention given to the plain box, the result would be equally satisfactory."

Mr. Wells, of the Jeffersonville, Madison & Indianapolis Railroad, prefers the plain box, but advises an increase in the size over that now in use on our standard engines. In his opinion the furnace should be longer and deeper—the grate area being the same as now—and, as a consequence, the steaming capacity of the boiler greater, so that the gases need not be "hurried" through the flues as is now done, but more time be allowed for combustion. He expresses the conviction that "boilers of coal-burners are, as a class, too small," and therefore do not burn coal economically.

Your Committee can not suggest any desirable changes in existing forms of locomotive furnaces. They see the necessity for better combustion and greater economy in the use of fuel, in furnaces of coal-burning engines, than can be obtained with any known device.

Your attention is invited to the suggestive words of Mr. Setchel, and to the views of other master mechanics, as herein submitted. From their own individual experience in past years, your Committee recommend the use of the fire-brick arch or water table in furnaces of all passenger locomotives burning bituminous coal; leaving out the question of economy in the use of fuel, we are of the opinion that either of these appliances lessens the volume of smoke and cinders thrown from the stack, and contributes to the comfort of the traveling public.

Your Committee also recommend the admission of air above the fire, through suitable openings arranged for the purpose. Passenger engines with furnaces arranged as specified run cleaner than those with a plain box and no air openings, they steam as freely, and it is highly probable that they effect a saving in the consumption of bituminous coal.

Your Committee recommend the wagon-top, in preference to the straight boiler, for locomotives, especially where impure water is used. It affords greater steam room, larger water surface over the furnace, and decreases the liability to foam when the water is bad. It is easy of access when the mud and scale must be removed from the crown sheet, or when repairs are necessary to the numerous braces over the furnace, and, as stated by Mr. Wells, of the Jeffersonville, Madison & Indianapolis Railroad, it distributes the weight to greater advantage upon an eight-wheeled engine, with four drivers, than does the straight boiler. The cylinder part can be smaller in diameter, and consequently lighter, than with the straight boiler, thereby lessening the weight upon the truck; while the furnace end will have greater weight, due to the wagon-top, and will give proportionately more adhesion to the driving wheels. The straight boiler can be built at less cost than the wagon-top, and is subject to fewer unequal strains; but your Committee think the advantages of the latter form more than compensates for the defects. Two domes are preferable to one, on boilers with limited steam space, and on boilers using impure water, provided steam is taken from both domes. Lesser variations in water level and dryer steam in the cylinders are obtained.

Where the water is pure, or the boiler capacity large in proportion to power of engine, one dome is sufficient.

Very few speak favorably of the perforated "dry-pipe" for locomotive boilers.

Your Committee recommend two-inch flues for wood and coal-burning locomotive boilers. In regard to burning bituminous coal with a draft from the top of the fire downward, we report that experiments do not warrant a conclusion favorable to the idea.

Mr. Van Vechten, of the Atlantic & Great Western Railroad,

reports that he has tried the experiment, but the results were unsatisfactory.

Mr. Robinson, of the Great Western Railway of Canada, writes as follows: "I have found highly satisfactory results in coal burning in ordinary fire-boxes, by using what is known as a removable deflecting plate bent about half round and inserted through the fire-hole, hollow side downwards, dipping toward the center of the fire (the fire door being left open when this is used), thus producing a downward draft of air upon the fire. The best results, however, I think were obtained by a current of air admitted immediately under the brick arch, which was directed downward by the inclination of the arch towards the center of the fire."

One of your Committee experimented with a water table secured to the back sheet of the furnace, over the door, and projected downwaard toward the center of the fire; the furnace door was arranged so as to admit of its being opened partly or fully, as occasion required, air was admitted continually through the opening and carried down by the table; a fire-brick arch was arranged in the front end of the furnace to throw the gases back and compel their mixture with the air admitted, as described above. The experiment was not successful. The volume of smoke was lessened materially, and the engine steamed fairly in warm weather; but in winter it was impossible to generate sufficient steam to enable her to perform her regular freight service.

Your Committee can not recommend an American iron for furnace sheets, as free from lamination and liability to blister as Low Moor and kindred brands of English iron.

A large majority of master mechanics from whom we have heard advise drilling instead of punching rivet holes in boiler plate. No tests of their relative strengths were reported, and your Committee, therefore, felt compelled to experiment in order that definite information might be given you.

The following tests were made, all the pieces being from the same sheet:

Three pieces of $\frac{5}{16}$ inch boiler plate, $1\frac{3}{4}$ inches wide, were torn in two by hydraulic pressure:

No. 1 broke under a strain of	32,228 lbs.
" 2 " " "	32,228 "
" 3 " " "	33,600 "
The average breaking strain being	32,685 "

Three pieces of $\frac{5}{16} \times 1\frac{3}{4}$ inch plate were *punched*, one $\frac{5}{8}$ inch hol being put in each piece. They were then subjected to a tensil strain, with the following result:

No. 1 broke under a pressure of	13,371 lbs.
" 2 " " "	13,371 "
" 3 " " "	13,714 '
The average being	13,485 "

Three pieces of $\frac{5}{16} \times 1\frac{3}{4}$ inch plate were *drilled*, one $\frac{5}{8}$ inch hol being put in each piece:

No. 1 broke under a pressure of	17,828 lbs.
" 2 " " "	17,485 "
" 3 " " "	17,622 "
The average being	17,645 "

The average strength of the drilled plate being 4,160 lbs. great than that of the punched plate. Great care was taken to dress th pieces to the sizes given after they were punched or drilled.

The following comparative tests were then made with punched an drilled plates riveted:

Six pieces $1\frac{3}{4}$ inches wide, and cut from the same sheet as the for going, were punched and riveted together, in pairs, with the best inch rivets, one rivet to each pair, and were subjected to a tensil strain, with the following result:

No. 1 broke in center line of hole under	17,828 lbs.
" 2 " " " "	17,828 "
" 3 " " " "	17 143 "
The average breaking strain being	17,599 "

Six pieces, duplicates of those last mentioned, were *drilled*, a riveted together in pairs, one $\frac{5}{8}$ inch rivet to each pair:

No. 1 sheared the rivet under a pressure of	17,143 lbs.
" 2 " " " "	16,457 "
" 3 " " " "	15,428 "
The average shearing strain being	16,342 "

You will observe that the rivets securing the plates having drilled holes, were sheared under a less pressure than was required to tear asunder the plates having punched holes.

It is also worthy of note that, while the punched plate is weaker than the drilled plate, the rivets in the punched holes do not shear so easily as those in the drilled holes. This is probably due to the edges of the drilled holes being sharper and more compact, and consequently more capable of shearing than the edges left by a punch. It is not probable that the tensile strength of boiler plate, per square inch of section, is impaired by drilling, but your Committee are satisfied it is impaired by the use of a punch.

In view of these facts we advise drilling the rivet holes for longitudinal seams of boilers; the circular seams are not subject to so great a strain and may be punched. We also advise the use of $\frac{3}{4}$ inch rivets, $1\frac{7}{8}$ inches from center to center, for all seams in locomotive boilers made of $\frac{5}{16}$ inch iron, as the $\frac{5}{8}$ inch rivet is too small to resist a shearing strain equal to the tensile strength of the plate between the rivet holes when they are drilled.

We are of the opinion that a drift should not be used in the rivet holes of any boiler; if the holes do not correspond a reamer should be used.

We think back flue sheets should be $\frac{1}{2}$ inch thick if of iron, and $\frac{7}{16}$ inch thick if of steel; front flue sheets $\frac{7}{16}$ thick if of iron, and $\frac{3}{8}$ inch thick if of steel.

In the various communications received from master mechanics, no changes of importance were suggested in the material or construction of locomotive boilers.

Your Committee have one recommendation to make, and that is in regard to stay-bolts for locomotive furnaces. We strongly urge the advisability of using hollow stay-bolt iron exclusively, so that if a stay-bolt breaks partly or entirely, it will be discovered immediately.

The objection may be made that too much cold air will be admitted in the furnace. This, however, can be readily avoided by driving suitable plugs into the inner end of the holes in stay-bolts. A boiler recently examined was found to have 40 broken stay-bolts. The boiler is $2\frac{1}{2}$ years old, and is stayed with $\frac{7}{8}$ inch bolts, $4\frac{1}{2}$ inches from

center to center. Another boiler was found to have 15 stay-bo
broken.

Similar instances are numerous, and we think safety demands so
surer way of detecting broken stay-bolts than that of getting in
furnace and sounding with a hammer. An examination of this k
is rarely made unless an engine is in the shop for repairs; and c
sequently boilers often run in an unsafe condition, on account
hidden defects of this character.

The remedy we suggest is thoroughly reliable. In order that
might have definite information of the strength of $\frac{7}{8}$ inch holl
stay-bolt iron, your Committee tested the tensile strength of th
pieces. The hole through the center was $\frac{5}{16}$ inch diameter and
sectional area of the metal $\frac{52}{100}$ of a square inch:

No. 1 broke under pressure of	28,457 lbs.
" 2 " " "	29,828 "
" 3 " " "	30,171 "
The average being	29,485 "

By experiments made a year ago, and submitted to this Asso
tion, we found that $\frac{7}{8}$ inch stay-bolts tapped into $\frac{5}{16}$ inch plates a
riveted over, pulled out under an average pressure of 21,486 poun
which is 8,000 pounds less than the tensile strength of $\frac{7}{8}$ inch holl
stay-bolt iron.

It is certain therefore that the strength of $\frac{7}{8}$ inch hollow stay-bo
is more than sufficient to resist the strains to which they will be su
jected, if placed $4\frac{1}{2}$ inches from center to center.

We submit herewith a drawing of a boiler complete, as built
Mr. W. A. Robinson, of the Great Western Railway, of Canada.

Respectfully yours,

S. J. HAYES,
Supt. Mach'y, I. C. R. R.
C. F. JAURIET,
Supt. Mach'y, C. B. & Q. R. R.
J. LAMB,
M. M., D. M. V. R. R.
Committe

On motion of Mr. Sellers, late of Des Moines Valley Railroad, it
voted that the report be received.

Mr. HAYES, Illinois Central Railroad—Before proceeding with the discussion of the report the Committee on Correspondence are ready to report on those communications which have been referred to them. If there is no objection, Mr. Robinson, the Secretary of the Committee, will read the report.

Mr. Robinson, Great Western Railway, read the report as follows:

REPORT OF COMMITTEE ON CORRESPONDENCE.

Correspondence submitted consisted of one invitation only beyond what had already been considered by the Committee on Invitation, this one being from the American Watch Company, and received too late for the necessary arrangements. We recommend that a vote of thanks be extended this Company for their consideration and proposition, but that the same be respectfully declined for the reasons mentioned.

The other invitations, which have had the consideration of the Invitation and Reception Committee, we recommend be accepted in the order presented, and

That all members who intend availing themselves of the New Hampshire excursion, will give in their names to the Secretary of the Association on or before 2 o'clock to-morrow.

S. J. HAYES.
E. O. HILL,
C. T. HAM,
A. H. DECLERCQ,
W. A. ROBINSON,
} *Committee.*

On motion of Mr. Keeler, Flint & Pere Marquette Railroad, it was voted that the report be received and the recommendations adopted.

THE PRESIDENT—The discussion of the report on Boilers and Boiler Material is now in order.

Mr. HAYES, Illinois Central Railroad—I was not present when that report was read; but, of course, I am familiar with its import, and I would like to hear an expression of the master mechanics present upon the subject. Your Committee have taken considerable pains to get up a practical report. It is true there is very little of theoretical opinion in it; nearly all of it is practical. In regard to the pulling of the iron in two, showing the difference in strength of iron between drilled sheets and punched sheets, we have taken considerable pains and considerable trouble; also in riveting sheets together

to compare the strength of a single-riveted seam and a double-riveted seam, and I should like to hear the opinions of those who were present to hear the report read. I am satisfied it would be entertaining to the Association, and we should profit very much by a discussion of the subject.

Mr. Hudson, Rogers' Locomotive Works—I would like to ask the Committee a question in regard to these plates that were punched and drilled, and that is, Whether the grain of the sheets was all in the same direction? It is well known that the strength of boiler plate differs very much whether with the grain or across the grain. I merely wish to ask the Committee if these sheets were all taken with the grain in the same direction. If so, then the tests are comparative and are of value; but if taken without regard to the direction of the grain I apprehend it throws serious doubt, or would throw serious doubt, upon the reliability of these experiments.

Mr. Hayes, Illinois Central Railroad—Your Committee was well aware that iron does not always present the same strength, taken from the same sheet, unless pulled in the same direction. They were perfectly well aware of that, and hence all of those pieces that the experiments were made with were taken from the same sheet and taken as the sheet was rolled, longitudinally, not crosswise. They were aware that a sheet pulled crosswise will not stand as much as when pulled lengthwise, and hence the Committee was very particular to have the strain longitudinal. The experiments were all made with a view of showing a fair test, and not to show that the iron was better than any other. We cut it all from the same sheet, so as to make the experiments a fair test. In the first experiment with the drilled sheets, the first three pieces we found, when we pulled them in two, that it sheared the rivets; it did not pull the iron in two, but sheared the rivets; hence we found where sheets are drilled it is necessary that the rivets should be made larger; in every case where the rivets were the same size, and where the sheets were punched, the sheets pulled in two and the rivets were not sheared. We found the same in steel in our former report. We found in our former report, also, that steel varied but very little, whether it was pulled crosswise or lengthwise, and we found ten or fifteen per cent. difference in iron, whether *it* was pulled crosswise or lengthwise.

The Secretary—I would like to ask Mr. Hayes, as the Committee have recommended increasing the size of rivets from five-eighths to three-fourths of an inch, in order to stand the tensile strain of the iron in drilled sheets, if it would not increase the strength in the same proportion if the sheets were punched, and if, in the end, we would not get a greater tensile strength to the iron by the punched sheets than by the drilled sheets by using the increased size of rivets?

Mr. Hayes, Illinois Central Railroad—We certainly would not get the same strength, because there is a positive proof that the drilled sheet does stand more tensile strain than the punched one, and hence all you have to

do is to put your rivets farther apart and of an increased size, and you get the increased strength between a punched and drilled sheet. I think that will answer the question.

THE SECRETARY—I did not understand the Committee to recommend putting them any further apart.

Mr. HAYES, Illinois Central Railroad—Certainly; farther apart and larger rivets.

Mr. HUDSON, Rogers' Locomotive Works—There is another question involved in this matter of punched and drilled sheets, which it might be well to understand in order to arrive at a correct conclusion. It is well known that the strain in punching a sheet depends very much upon the size of the die as compared with the size of the punch. If the punch and die are of the same size precisely, the sheet is strained very much more in being punched than it is where the die is slightly larger than the punch. In that case you make a conical hole. Again, in riveting sheets so punched it is important to know which side of the sheets are put together—whether you put the two large sides of the holes together. If you do, you get a large section of the rivet when it is driven and sheared apart, and possibly if they were put together in that way, there might be a large section, and that might account for the rivets not being shorn apart in the punched plates when they might be, with the same size, if they were put the other side to.

Mr. HAYES, Illinois Central Railroad—Those sheets that were punched were punched with a keen, sharp punch, and hence there was but very little difference between the upper side of the hole and the under side; and in putting them together we were not particular whether it was the upper side or the under side of the hole. But we all know in the force required to send a punch through a five-sixteenths sheet of iron you must start more or less of the fiber of the iron some distance out from the hole, and hence it must weaken the iron. If you take the two upper sides of the hole, which are invariably a little larger than the two undersides, and put the rivets in the other way, I believe the sheet would stand a little more than the other way; but, at the same time, where sheets are punched with a good, sharp punch, and a die that fits the punch, you must get a pretty true hole, and it must show a pretty true conclusion of the strength of that material. If you take a microscope you will find, when a sheet has been punched, there are little lines all around the hole where the fiber of the iron has been started, and hence the iron must be weaker. The pieces we punched were of a certain width; we punched the hole straight through the metal and then took a plane and planed them out so as to get precisely the same size on each side of the hole to the outer edge of the metal. We were very careful to get that correct, then we took hold of the two ends and pulled it in two. If you get one side a little narrower than the other side that would give way first, and it would not show a fair comparison of the strength of the metal; but when

we were careful to get the exact size on both sides, I think we got a conclusion pretty correct, and I am satisfied—it showed very conclusively to my mind—there was a great difference between the punched sheet and the drilled sheet; and hence we recommend that where the strain comes greatest upon the boilers the sheets be drilled. In the other parts, the longitudinal parts, where the strain is not so great, punched sheets will answer every purpose.

Mr. HUDSON, Rogers' Locomotive Works—I don't know that I made myself understood entirely in regard to that question of punched sheets. I wished to state that it is a fact that sheets are deteriorated in punching to a very much greater extent where the punch and die are pretty accurately of a size than where the die is largest. I know that to be the fact, and therefore I say it is important to understand it. Mr. Hayes, I think, has clearly stated that the punch and die were very nearly of a size. I stated that in that case the punching deteriorates the iron to a much greater extent than it would if the die was a little larger. Then, again, in punching sheets they wear the punches too long; in other words they become taper, and after entering the drift at the base they enlarge the hole. That is what injures punched sheets, in my estimation. I am certain that, with the tools kept in perfect order, and with careful attention paid to the size of the die, the deterioration in punching over that in drilling is not as great as is generally supposed.

MR. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I presume that the effect of a punch in a rivet hole in a piece of boiler plate, either of iron or steel, is precisely that of a punch in a nut, and we all know that cold-punched nuts when tapped seldom show a perfect thread. You must have the hole the same size that the drilled hole is, and when you come to cut out a portion of that metal with the thread of the tap, the remainder will show a ragged and broken edge, and wherever it presents that appearance it is evident that the metal is not perfectly solid. It looks to me reasonable that a punch, under the best of circumstances, will, to a certain extent, depreciate the strength of the metal—the metal immediately around the hole. The particles are driven down, and there is a sort of a wedging process brought to bear upon that metal immediately around the hole, and that, together with the strain that is upon the iron, brought by the pressure, the tensile strain will necessarily break it sooner than if the metal is left entirely free from strain when the rivet is put in. I don't think it makes much difference with the holes in the seams running round the boiler, whether they are punched or drilled, because there is sufficient strength there under ordinary circumstances with a punched hole with the poorest punch. The longitudinal seams of the boiler should be left in the strongest possible condition, and in order to get at that I don't think there is any way so good as to drill those holes.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I think the report of the Committee was, that they find no American brand of iron to compare with

the Low Moor for locomotive boilers. I would state that in my experience there is at least one brand of American iron which I consider equal to the Low Moor iron—the Sligo iron. I have used it for some years, and I think for all locomotive iron it proves fully equal to the Low Moor. I do not include fire-boxes. I think we must all have realized before this time that steel is so much better than any brand of iron for fire-boxes that it is hardly worth while to take time to consider the use of iron for that purpose; but for the shell and flange I find the Sligo iron equal to the Low Moor.

Mr. HAYES, Illinois Central Railroad—If the Secretary will be kind enough to read the question here that was propounded to the master mechanics, it will show what the intention of that question was in regard to the use of Low Moor iron.

The Secretary read, "Do you know of an American iron for furnace sheets as free from lamination and blister as Low Moor iron? If yes, state the brand, and the length of service of the sheets."

Mr. HAYES, Illinois Central Railroad—If Mr. Elliott will notice, he will see that the inquiry was propounded as to furnace iron, not for the outside shell. There is no lamination at all on the outside shell. It is the blistering, etc., on the flue sheets and sides of the furnace. We find out West, where the water is very bad, and such scale as this (one of the samples exhibited at the meeting) is formed on the crown sheets—we find it impossible to use steel for the crown sheets. The steel becomes hardened, and that formation is formed on the top of the crown sheets, and the water is kept away from it and the crown sheet bulges downwards, and when we go to straighten it up we find the crown sheets crack; hence we have been using Low Moor and other soft iron. That was the object of that question. I am satisfied when you come to the shell of the boiler that Sligo iron will beat Low Moor; but it will not, in my experience, neither for crown sheets nor for furnace sheets. In every case that I have used it I have found that the sheets were not solid; after a while they blister, and sometimes in drilling them I find the washers come out in two pieces. It is a series of layers of iron put into a furnace and heated and hammered and run through the rollers, and some of the layers do not get firmly welded, so that when we have drilled them they would come out in washers. When I used them in furnaces, the side on which the water was would be contracted and the side on which the fire was would bulge out and be chipped off; and hence the flue sheet was only half the thickness it ought to be. That is the case with all American iron I have seen; but in steel, that being cast and then hammered, there are no seams at all, and hence you do not find any in the steel sheets; but for crown sheets and for flue sheets I have always found that trouble with American iron, and some of it with English iron, but less with the Low Moor than any other brand.

Mr. PHILBRICK, Maine Central Railroad—There is one point slightly

touched upon by the gentleman about the shearing of the rivet. The idea that there was more iron in these was clearly brought out; but the idea that the rivet sheared in the drilled sheet, because the corner was square, seemed to be given as an objection; the statement was that it sheared easier because the corner was square. We can correct that by rounding the corner a little; but from what the gentleman says in regard to punching, I think there may be a question as to the correctness of that reasoning. He says it punches easier if the die is larger, making the punch come down not directly square across and punching it, but by giving it a chance to bend a little and carrying the particles through easier. If you say that it shears so easy because they are so close together, you have started another system of shearing which, I think, in good iron, we have pretty well established is not true. I think you can take off a large bolt, and you are more liable to take it off when the particles are a little apart than when they are close together. I don't think you can round your hole and drive a rivet that shall not fill that corner. I think the reason the rivet sheared easier was because there was more iron in there, which was true. The reason it sheared easier in the drilled hole was because it was smaller. In the punched hole you have more iron to cut off. I don't think the square corner is quite the reason it shears so easy.

Mr. MAYNES, Selma, Rome & Dalton Railroad—I can not agree with Mr. Hayes in regard to Sligo iron. I have had experience with that iron. I had charge of building two boilers made entirely from that iron, in which we drilled all the holes. I superintended the drilling of the flue sheets, and I found no disposition of the iron to make washers that he speaks of. I don't think there was a hole in it that came out in that way. I think it equals the best. I think we owe it to our home manufacturers to stand by them when they make good iron like the Sligo.

Mr. HUDSON, Rogers' Locomotive Works—This question of iron and of the comparative value of American as compared with Low Moor and other English irons, I think is very important. My experience with Low Moor iron is like this: that while Low Moor iron is well manufactured it is free from lamination and will stand fire, at the same time it is tender. You have got to be careful in working it, in flanging, otherwise it will break on your hands; also in riveting it; if you have to bend it a little you must warm it, otherwise you are liable to crack it. I think I can safely say that there is a brand of American iron, and possibly more than one—at least I can speak of one—which, so far as we have used it, and we have used a good deal of it, is equal to any Low Moor iron and is free from lamination, and, so far as its tensile strength and ability to stand hardship in flanging, and planing, and twisting in every direction is concerned, will stand a great deal more, and that is the iron made by Bailey of Douglasville, Pennsylvania. I am not afraid to brag upon his iron; and I think it is a matter of justice, and

justice to American iron, to say there is a brand of American iron which is in all respects, in standing fire, equal to the Low Moor, and in other respects far superior as having more tensile strength.

Mr. HAYES, Illinois Central Railroad—I don't wish to have it understood that I came here with a view of advocating English iron or any other brand of iron. I am an American, dyed in the wool, and therefore if we have got an American iron that will beat our foreign irons, let us have it. That is what we came here for. We came to discuss these matters, and if any gentleman knows of any better iron I am the one to adopt it to-morrow. I would like to hear from all these gentlemen and get their experience, and that was the object of our circular, to find out whether we could get an iron that was equal to the English iron; if we can, I say let us adopt it and use it throughout the country.

Mr. GORMAN, Toledo, Wabash & Western Railway—The question of iron seems to be on the tapis now. There is another brand of iron I have been using for the last six years. I don't know whether it has come generally into use in the East or not. It is the Tennessee charcoal iron, and I must say I prefer it decidedly for boiler shells. We don't use any iron in the furnaces. I have used the Tennessee iron and I have never had one bad sheet, never have been able to find one that had any tendency to blister, or have any seams through it. I have a very good boiler-maker who has been previously in favor of Sligo and Low Moor iron; in the last years he says he don't want to use anything better than the Tennessee iron.

Mr. FLYNN, Western & Atlantic Railroad—I will corroborate what the gentleman says. My supposition is this, that so far the Tennessee iron has never had the opportunity, which most of the irons in the United States have had, to have the justice which it ought to have. I myself am of the opinion that it is equal to Low Moor iron. I have used it, and I have used the Low Moor iron and the Sligo iron likewise, and I must say, without prejudice, that I think the Tennessee charcoal iron is equal to any iron used in this country. I hope the master mechanics, if they have an opportunity, will give that iron a test. It is manufactured in Tennessee, and the principal office, I think, is in Louisville. By using it we might be able to demonstrate, by our next annual meeting, whether it is not equal to any iron we have.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I have used that Tennessee iron myself, in connection with Sligo, and I think it is fully equal to Sligo. I would like to make a remark in regard to Mr. Hayes' idea of using iron for crown sheets and flue sheets in preference to steel. That is not my idea. I prefer steel for crown sheets, and any other place where there is a tendency to deposit any foreign substances. We want something that is homogeneous and will not split and blister. I have been using steel crown sheets, and we have very muddy water. I had one case where from a deficiency of water,

which all locomotive engineers understand, the engine was what we call "burned." The crown sheet came down and formed nearly all over the sheet in dishes between the stay-bolts as much as three-fourths of an inch, and the sheet was taken out and the dish straightened out, annealed, and put back in the fire-box, and has run since that time, three years, and shows no signs of defects. The engine was a Grant engine, built in 1868.

Mr. Grant, late of Rockford, Rock Island & St. Louis Railroad—I should like to know the brand of steel of which he speaks.

Mr. Elliott, Ohio & Mississippi Railroad—I am not able to state the brand of steel that I spoke of particularly in this way. It was an engine built by the Grant Locomotive Works. I have had no trouble with it whatever.

Mr. Grant, late of Rockford, Rock Island & St. Louis Railroad—I think it is important that the brand of iron or steel should be given; not as an advertising medium, but that we may know the brand and know where to purchase a good quality.

Mr. Hayes, Illinois Central Railroad—In regard to the use of steel in flue sheets, we have used the brand of Hussey, Wells & Co. and Park Bros.; and after running from four to eight or ten months, we find when this lime deposit becomes very thick on the crown sheets they bulge down between the stay-bolts. We find it necessary to take off the crown bars to get that deposit off. When we do that we build a charcoal fire, leaving the crown sheet in its place and force it up into its proper place. In doing that, with steel sheets, we find in almost every case that they crack through the holes where the crown bars are fastened, but not when we have Low Moor or other good brands of iron. Sligo iron, if it did not laminate, is as good as Low Moor; but it is more liable to laminate and to separate between the seams. There is one other brand of steel (almost all we have used has been the Hussey, Wells & Co.), Park Bros. Black Diamond Steel, but we found on straightening that up after they had bulged down (and they will do it when you get a large amount of deposit and the water is kept away from the sheet, it must become heated and bulge down), that it would crack between the bolt holes. If it didn't do that, I would rather use the steel. I am using steel for side sheets and back sheets of furnaces; but in the flue sheets I find that steel becomes hardened after using it awhile, and they are more liable to break. Where you have good water I should say use steel throughout in the whole furnace, and nothing else. Some of our Western roads have had to abandon steel and have gone back to copper. I think the Chicago, Burlington & Quincy Railroad has gone back to copper entirely. I use steel except for flue and crown sheets.

Mr. Hudson, Rogers' Locomotive Works—I should like to make a few remarks in regard to working steel and iron sheets for furnaces. Perhaps it is hardly in order, but I think it would be a matter of interest. We find

that in all sheets that require flanging the tendency is to warp and distort the sheets and crook them all up. While in that condition we find it necessary to heat them uniformly all over—heat them in a furnace and then let them cool—and the durability of furnace sheets is very much enhanced when treated in that manner. I know that many railroad shops, for want of the proper facilities, are in the habit of flanging their sheets and keeping them straight; in other words, putting the strain of the difference in the length all into the sheet. The tendency is it only watches for the first opportunity and it cracks. Then it is said to be the fault of the sheet, whereas the sheet was not so much at fault as the mode of working it. The subject is one that is of vital importance—the durability of sheets in furnaces, whether of iron or steel.

Mr. ELLIOTT, Ohio and Mississippi Railroad—I agree with Mr. Hayes that iron is preferable for crown sheets, if that is the treatment he proposes to put them to. I don't see any reason for such treatment of crown sheets. We have such things happen, but we have it much more seldom with steel than iron; but if they crook and have to be straightened, iron would stand it better. The sheet I spoke of I took out entirely, but it held out so well it didn't show any bad effects. To attempt to straighten a crown-sheet, even of iron (I have done such things), is the greatest risk. The chance is you will produce a crack before you get the sheet straight. Sometimes you have to do it; but I think Mr. Hayes will agree with me that the accumulation of such an amount of material on the top would only occur once in a great while. If it was a common occurrence there should be some means of cleaning the crown sheet.

Mr. EDDY, Boston & Albany Railroad—I recollect, in attending our Convention some two years ago, that the master mechanics then were pretty much all steel. My friend Hayes thought, if I recollect right, at any rate I gathered it from what he said, that there was nothing else fit to put in a furnace in any shape but steel. I see he is creeping back a little; not creeping, perhaps, but walking upright, and he is coming round by degrees where I think all roads that have a heavy traffic will soon be—that they will not use any steel for fire-boxes on their roads. I have had considerable experience that way, and I am decidedly opposed to using steel in fire-boxes in any way or shape.

Mr. SEDGELEY, Lake Shore & Michigan Southern Railway—I wish to say a word in regard to my experience. Up to six or seven years ago, upon the Lake Shore and the Michigan Southern & Northern Indiana Roads, we had been using for crown sheets and flue sheets almost exclusively, different brands of iron. Upon some portions of our road we suffered severely from bad water, from an excessive accumulation on our crown sheets and tubes. I found that even by the use of the best of iron, Low Moor, Sligo, Pennock—all the different brands I knew of—it was almost impossible to make a crown

sheet stand over three years with the very best attention you could give The same was true of the tube sheets. At that time, or previous to th time, we had imported perhaps a dozen steel sheets from the Canada Comp ny's Works, which were put in, and I think, without an exception, the tu sheets are whole to-day; and of the crown sheets that were put in not one h been removed or required patching; so far as my experience goes, I belie that one steel sheet for a crown sheet is worth two iron ones of the best qu ity I have seen. As the Committee on Boilers referred to tube sheets, would like to ask the gentleman's objection to steel for that purpose. It is matter that I am interested in. My experience, although limited, perha to what some of the other gentlemen have had, leads me to believe that st is far preferable to iron.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I was just going to ask M Eddy what brand of steel he had had his experience with. Another thi we must take in connection with it. We must take into consideration t fact that the manufacture of steel only dates back a very short period, a some may come to a wrong conclusion from having unfortunately got in their hands a poor brand of steel. I think what is said here ought to ha some weight to lead a man to think whether he has not. When I state th I have never had a sheet, in building twenty boilers, never had a steel sh fail, certainly it goes a long ways in establishing steel for that purpose. M Eddy may have had a poor brand of steel.

Mr. EDDY, Boston & Albany Railroad—My experience has been alm altogether with Hussey, Wells & Co.'s brand of steel, scarcely anything el We had occasion to take a part of a sheet out of a boiler not long since, a I found I could take a common hand hammer and strike the sheet where was flanged and it would fly like glass—steel that they claimed was the b steel they could make, and was the best in the market to put into boile The engines were built at the Grant Locomotive Works, and I know t work was well done, and the material was said to be the best. That was t character of that steel. It cracked from the holes out very badly, and it w very brittle. As I said before, you could take a hammer and knock it pieces like glass. I meant to have brought a specimen here, and remark to a gentleman since I have been here that I was sorry I had not brought You can take a common hand hammer and knock the flange off.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I should like to ask the ge tleman if he knows whether that steel was punched or drilled. I think th is a vital point for us to know; also, whether that steel was of the requis character. I do not intend that a piece of steel shall be used in a furn that will harden by heat. I don't believe a sheet should be put in that y can harden.

Mr. EDDY, Boston & Albany Railroad—The steel would not harden. tried it, but could not harden it. The Grant Locomotive Works built fo

engines for the Boston & Albany Railroad. They built them as sample engines, and agreed to, and, so far as my knowledge goes, did, put in the best material and workmanship, or as good as any engines we ever had, and they put that steel in because they thought it to be the best thing that could be obtained. I have had other experience besides that just as conclusive to me. I don't know that I can go the ground over in all its minute details; but suffice it to say that my experience has been very bad with steel fire-boxes, and I have had very bad luck with it, if there was any luck in it; so bad that if left to my own inclination, I should not put in any more unless I saw a great change in steel. I am not here to advocate or to please any man or any set set of men. We come here for information; we don't come here to bolster up this thing nor that thing, nor this material nor that material—simply to tell without fear or favor our opinions and to consult together as to the best thing for our railroads, and to get at the best thing in the market.

Mr. Gregg, Erie Railway—It has occurred to me that the drift of this discussion has taken a different direction from what it did when it first commenced. If I understood Mr. Hayes he was not discussing the question as to whether steel was better than iron for fire-boxes, or iron better than steel, *in general;* but only that iron was a better material for him to use (where he had bad water) than steel, simply from the accumulation that collected on top of the fire-box; hence he preferred iron to steel on that account simply, not because steel was *generally* a poorer or an inferior article to use than iron, but because it was a better material to use when there were great accumulations on the top of fire-boxes. Perhaps he is right there. On that, I can not tell, because I have never had experience in that direction at all. The water, wherever I have had any experience at all, has generally been good, and the accumulation in the boiler very little indeed. We have never been bothered in that direction. There has been some discussion here as to whether iron is not better than steel, and whether steel is not better than iron. Our friend Eddy says he prefers iron, and seems to think that Mr. Hayes is going back gradually, commencing with the crown sheet, and will after awhile get to the sides and the whole thing will be of iron. My experience with fire-boxes has been in favor of the use of steel; for a long series of years my experience was with the Bowling iron—the English Bowling iron—and I presume a large number of the master mechanics here to-day have used the Bowling tires that were imported years ago. Perhaps very few of them are imported now; but the Bowling and Low Moor tires were very generally imported and generally used. Both were used on the Erie Road twenty-five and thirty years ago, and down since that time to within ten years ago, we used many of them. I have some of them now in use; but I don't think more than two or three out of two hundred engines. I used the Low Moor tires, but they did not wear in comparison with the Bowling at all. They sheared off and laminated very badly indeed. Of late years we have

adopted steel for fire-boxes, simply because we could not get iron that wou stand the use of coal as fuel. We used Bowling iron, of which we importe largely some years ago, and the last importation of which was made in 185 Those sheets, many of them, were used up to somewhere about 1860. I use the last, I think, in 1862; and I will say that one of the engines I built i 1862 has that fire-box in yet, of Bowling iron. We have imported some that since, but only a few sheets. Since that time we could not get Bowlin iron equal to that which we imported in 1852. Our last large importatio was in 1852. It was a very superior article. Now, on the Erie Road, I thin very generally, at any rate in the Susquehanna shops, we have adopted th steel fire-box plate, or steel plates for fire-boxes, and they have been unive sally, with the exception of a very few sheets, the Hussey, Wells & Co. steel. I don't know that I can mention a single instance of a sheet whic has been put in at Susquehanna which has given out. We have had quite number of sheets give out in engines that have been built elsewhere—engin that the Company have purchased; they have given out in the flanges, an I claim they gave out as Mr. Hudson says, mainly because of the careles ness in flanging—the strain put upon it in flanging, and in not annealing th sheet after it was flanged to take the strain away from it. Where the strai is taken entirely off the sheet after it is flanged, as we do in the Susquehann shop, I can say I don't know of an instance where a sheet has given out. C course they will burn out; fire-boxes will burn out after a time; but the have not given out from any cause, from inferior quality of the material use as in comparison with iron; and as one of our members here said, a fe minutes ago, that one fire-box of steel would outwear two or three of iron, will say I think I can corroborate that remark; that certainly a steel fire-bo will, I am safe in saying, outwear two made of iron.

Mr. Gorman, Toledo, Wabash & Western Railway—I like to hear thi discussion. It tends to draw out opinions that will be beneficial to all. S far as steel and iron boxes are concerned, there is a great difference betwee the kinds of coal used. The coal in Illinois is full of sulphur and salts c other substances that tend to destroy the life of the iron. I have had fir boxes that have been only a year and a half in use, and the sheets woul crack. I have seen one crack on the road and had a temporary patch pu on it to bring it home, when it got home the boiler-makers were put to wor to put a patch there. I was down on my knees looking in, and while lookin in (one of the boiler-makers had tapped it with his hammer and pronounce it all right, and had started the water to running, and it had got up about a high as the patch) I saw there was a crack on the other side. We took th fire-box out and you could do what Mr. Eddy said he could with his ste plate. This one had only been in use a year and a half. Then we use steel, and I have steel boxes running now four years and over that I hav never touched a hammer to, and they seem as good as they were the day put them in. I think the coal has a good deal to do with it.

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—I would like to ask Mr. Eddy how long that engine has been in use, of which he spoke?

Mr. EDDY, Boston & Albany Railroad—I can't tell; I should say four years or somewhere in that neighborhood.

Mr. HAYES, Illinois Central Railroad—I would like to say a word or two in reply to Mr. Eddy. He seems to accuse me of threshing about a bush or being astraddle of a fence. If he will take my reports from the first up to the very last, he will not find a single word where I recommend steel for crown and flue sheets. There have been four reports, and this makes the fifth, and I think he will not find a single word.

Mr. EDDY, Boston & Albany Railroad—I don't say I got it from the reports. I got it from the conventions.

Mr. HAYES, Illinois Central Railroad—If I saw steel was not the thing, I would be the last man to advocate it; or if I saw steel was better than iron, I would not advocate iron. I say if we had good, pure water, as they have on many of the roads East and South, I should say use steel for every part of the furnace, from the crown down to the sides, back, and flue sheets. I advocate the same things that were advocated in my first report. I believe it was correct then. There are some things on which I have changed my mind, after experimenting; but the main part of my first report will agree with the main part of my last.

Mr. HUDSON, Rogers' Locomotive Works—I would like to make a few remarks in regard to the quality of American steel for furnace purposes as compared with English steel. In fact, the American steel can hardly be said to be steel at all. It does not contain any of the properties which we usually attribute to steel. One of those very important properties is, that it shall become hardened when heated and plunged in water. I apprehend that it contains less carbon than a great many of our samples of iron that we don't pretend to call steel at all. What I wanted to say about it was this: we have recently imported English steel made on purpose for furnaces, and we find it is very much harder, and it has got to be worked very carefully, and if you flange a sheet down cold, it is in danger of falling in two. I have such a sheet in the yard now. That shows that the steel they are making is too hard. A few years ago we put quite a number of steel tube sheets into engines, but eventually we had orders to abandon it. The reason was, they were breaking all the time; we could not get them to stand. It was English steel. The American makers are gradually getting so that they can make wrought iron with no carbon in it, or so little that it can not be called steel—it is homogeneous iron—which is free from lamination, and that is where its superiority for furnace iron arises.

Mr. ROBINSON, Great Western Railway—I am very sorry I was called away from the room during the reading of the report, and am not familiar with the points touched upon. For that reason I was going to suggest, before

I proceed, that it would be an advantage in the discussion if w each question read and discussed by itself. Then there would danger of passing from steel to iron and from iron to copper, a boxes to tires, and so on. So far as this discussion is concerned are all right; that is, a person in the South finds it necessary clothes, and a person in the North must wear furs and skins to warm, so with the different roads in their relation to the questic cussion; everything depends upon the circumstances governing lar road. For that reason, I think a road that is troubled wit kind of sediment is a very unfair sample for the whole country. therefore, is an exception to the rule; and for that reason I th each of us consider each road by itself, and its locality. In like this we are all quite willing to give way to the experience ple, and allow each his portion of the discussion to come in as the basin of knowledge which we hope to stir up and get the still we must remember that each person's experience and opin regarded in connection with the circumstances governing then point I notice is that of the iron of the different countries. Yo urally suppose that, my origin being English, I would be in favo Moor iron, and you must be surprised to know that I am not i Low Moor is Yorkshire iron. There are four or five brands. one, Bowling is another, and Farley is another. These three famous brands. In making out a specification for a locomotive we say Low Moor or other Yorkshire iron of equal quality, a means Yorkshire iron with the same care taken in producing t have used Low Moor, Sligo, Bay State, and Pennsylvania iron sider, for all general purposes, the Sligo is quite equal t iron. During the time I have been on the Great Western Rai built twenty or thirty boilers. My boiler-maker looks upon i Low Moor, and the reason we do not buy it is because there is advantage in the price in Low Moor. I wish to ask our friend question, which I shall be glad to have him answer: Whether be better if for crown sheets he was to use a thinner layer of s sider that thin iron is a quicker conductor of heat than thick seems to me the difficulty might be obviated, partially, at least, The great mistake they are making in Europe to-day is in the of thick boilers. I was in Europe last spring, and I saw boilers thick in Glasgow and also in Manchester. It seems to me ri cause, though they get strength in the main body, in the rivets it and lose the strength there. I think that Mr. Hayes might, tage, try a plate $\frac{1}{4}$ or $\frac{5}{16}$ of an inch thick, with stay-bolts three It seems to me that will throw off deposit much quicker than Then, in bending up the plate, if it was thinner, it would not l

strength so quickly and might be bent up into its place. In regard to English iron for fire-boxes, I think one of the members of the Convention spoke of dispensing with steel entirely. We have gone through a great many changes—copper, steel, Low Moor iron, Sligo, and other descriptions. Some of our engines were built in Stephenson's shop at Newcastle-on-Tyne, and in breaking one of these (we are breaking up all our engines and introducing the American style of gauge) we took out the fire-box built by the makers, and in taking it out it flew all to pieces like glass. You might take a piece a foot square and tap it and break it. That engine had been running with one hundred and ten pounds of steam up to that time. I felt a sort of fear, and thought we were running an unwarrantable risk with the engine. It shows that the iron had undergone a change. I considered it had been converted into steel. It had no fiber at all; it was more like cast iron than anything else. If iron turns in that manner, I don't think any of us would recommend it. The iron in that state seems to become more brittle. Steel being of that nature and prepared suitably for it, and made much thinner than that iron is, I think is less liable to this fracturing or brittling process than iron or copper. Copper acts in the same way. When we have taken out copper boxes, I have seen copper that you could break in two like an ordinary biscuit. That is due to the burning of the copper sometime when we have not been aware of it. With the steel boxes we have not had any complaint whatever. Firth, of Sheffield, seems to be a good brand. When I say that England might produce the best iron, I might also say that America produces the best steel. I don't think there is any reason for entering into a discussion that would lead to anything like feeling on such a point. It is almost a commercial question only, and I don't think any mechanic wishes to make this Convention a medium for conveying trade from one to another. What we want to get at here is the facts.

Mr. Robinson's motion that each question be read separately and then discussed, was then agreed to.

The first question with the reply thereto was then read by the Secretary.

Mr. Eddy, Boston & Albany Railroad—I don't believe we shall any of us know much more than we do now if we discuss that all day. I move that it be passed without discussion.

The Secretary—I hope that motion will not prevail. If I understand the matter, we are here for the purpose of discussing these questions, and therein are we to get the chief benefit from the reports. The reports may be able and exhaustive, but there are experiences that may be detailed by each member that will be of infinite value to us when we go home to our shops, and I hope the discussion will be continued if it takes all the week. Let us attend impartially to business while we are here.

Mr. Eddy, Boston & Albany Railroad—I did not make it to choke off anybody or stop discussion.

Mr. FORNEY—Before proceeding with this discussion I think it would be a good plan for the members to exchange views with each other, and I move that we take a recess of ten minutes.

Mr. ELLIOTT, Ohio & Mississippi Railroad—In that report there are two or three points we can discuss to good advantage. That is, the subjects we have had under discussion and the advantages of the wagon top or straight boiler. There are points there worth consideration. I don't think it is worth while to spend too much time on them, although they are important, for if we take up every subject, and every man is to have his say, we shall never get through with the meeting.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—As this question is now before us, I hope any and every member who has anything to say upon the subject will get up now and let us hear what it is. If no one has anything, we may as well pass that and go to the next. For my part I have had no experience with any but the plain fire-boxes.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I look at it in this light—if it is voted that we discuss it, and any one has any remarks to make, let him go on and make them ; if not, this motion disposes of it at once.

Mr. EDDY, Boston & Albany Railroad—I did not make the motion to stop discussion ; I thought we could spend our time to better advantage—that is all.

Mr. Eddy's motion was lost, and Mr. Forney's motion for a recess agreed to, and the recess taken.

THE PRESIDENT—Has any one anything to say on the first question on boilers and boiler materials?

Mr. GRANT, late of Rockford, Rock Island & St. Louis Railroad—Coming from the different sections of the country as we do, we all come with different conclusions, with our minds made up from the localities in which we are. Different kinds of iron and different kinds of coal are used in different localities, and also different kinds of water. Where I have been last engaged we have seven locomotives with steel fire-boxes, known as Lancaster engines, five of which (none of them have been in use three years) have been almost entirely out of use for two years on account of the steel fire-boxes. I must say, for one, that from this experience I have been very much discouraged with the use of steel. I prefer Tennessee charcoal iron for fire-boxes.

Mr. HAYES, Illinois Central Railroad—Mr. President, I would like to ask the gentleman what brand of steel he is speaking of.

Mr. GRANT, late of Rockford, Rock Island & St. Louis Railroad—I have no way of ascertaining except upon examination of the fire-box from which it was taken out, and we could find no brand whatever. We cleaned the plates to discover the brand of the steel, but were really unable to find any. I don't know that what I say would come exactly under the head of this

question; but I am in favor of using the plain fire-box; that has been my experience in the locality in which I have been engaged.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I suppose the subject of brick arches comes under this head. To test the brick arch we had them put in alternately. The odd numbers had the brick arch and the even numbers the plain fire-box. We commenced running, and for a long time it was a very difficult matter to tell whether there was any advantage in one over the other in steaming or in consumption of fuel. Apparently, at first, there seemed to be a little advantage in favor of the brick arch; but it was first one way and then the other. The different trains and circumstances might have made all the difference. Of course there were different men running the different engines. We run them until the brick arches failed. I was very particular to tell the men to watch and see if they could tell any difference after the brick arch was taken out, and previously when it was all in good shape, and I believe the general conclusion of all the men was that there was not enough difference, not enough advantage, to pay for renewing it, and therefore we have not renewed our brick arches. I believe that is a fair test. I have watched it very closely, and that is our conclusion.

Mr. HAYES, Illinois Central Railroad—I would like to ask Mr. Elliott, supposing there were no difference in the amount of fuel consumed, would not the prevention of gas passing off and annoying the passengers in the train compensate for the expense and use of the brick arch?

Mr. ELLIOTT, Ohio & Mississippi Railroad—I think not. I think this can be overcome in another way. However, these engines were all freight engines; they were not used on passenger trains, where we were more particular. These engines all went into the same service, and performed the same service as near as we could determine it, with substantially the same consumption of fuel. All railroad men know the difficulty of exactly reaching the points of the number of cars, the tonnage hauled, etc. It is a very difficult matter to get at exactly; but I think the general use of forty engines, altogether, is a better criterion than any figures we can find.

Mr. SHAVER, Pennsylvania Railroad—We used the brick arch altogether in all of our passenger engines. We have two freight engines that have been at work two years in December, in one of which I put a brick arch, the other having the plain fire box. The one with the brick arch has burned less coal and done the same amount of work. Both run on the same schedule. The one with the brick arch has, if there is any difference, the most work to do—more shifting to do. The one without the brick arch has had the flues all taken out once, and part of them twice; whereas the one with the brick arch has never had any flues taken out. There appears to be in these engines a decided difference in favor of the brick arch.

Mr. MAYNES, Selma, Rome & Dalton Railroad—I have had some experience with one brick arch. I think it was in February last we

got the last of fifteen engines that were built for the Company, an last one came with what is called the brick arch. She made one on a passenger train, and after that laid in the house until I went out her afterwards for a trial trip over the road. Mr. Tucker was very ious to have the engine tested thoroughly. She was got up for the pose of burning coal. We used hard wood, what we call buckhorn, knots and pitch. We left Selma with an ordinary train, starting out twenty-seven cars, nine heavily loaded. Fifteen cars are an ordinary We go as high as seventeen—depending upon how heavily they are loa but fifteen is an average good train. We made a good run with the horns. They will make as much smoke as any bituminous coal, and she had them she made steam freely. At Calera we had to take st wood, and then she failed on me and got stalled twice before I got in the passenger train ought to pass me. There I left her. She came in twenty cars and the nine loaded ones that same day to Childersburg. from there she took straight wood a short distance out to Alpine where got hold of some of this buckhorn, and had no trouble in getting in when she got back to Selma she had made six hundred and forty The ordinary work of an engine is three hundred and twenty miles round trip. She had doubled back part of the way. She made six hu and forty miles and burned half a cord less wood than an engine ru three hundred and twenty miles. We used it until the brick arc down. The first brick were two and a half inches thick. They sent extra set five inches thick, and we used them until they were burne The difficulty with the brick arch is it is almost impossible to keep fi from throwing wood against the brick. They would get out on the roa throw in the wood and down the brick would go, and we would have up a little derrick in the fire-box to get the brick up. If the thing co put in so as to stay there, or for use with coal, I am in favor of the arch, perhaps with some change in the front end. I think if we had it again and taken pains to keep the front end clear she would do very

Mr. GREGG, Erie Railway—The discussion seems to turn upon wh this brick arch is any improvement on the common plain fire-box. I used the brick arch, some years ago, as perhaps almost all the maste chanics have used almost everything that has been offered that looked to economize fuel. I am like the rest of them, having experimented wit arrangement and that arrangement, until of course, like the most c master mechanics, I have got about tired out with all of them. Al year ago, in order to test the plain fire-box and know whether it w about as good as anything we could get, we made some experiments a quehanna both in freight and passenger engines. I have the result of experiments here, which I will simply note down, as these gentlemen not brought forward any data whatever to determine whether their pla better than the plain fire-box. I want to give these figures, and gentl

can make use of them as they think best. We have four forty-ton freight engines at the Susquehanna shop, two of them running west and two east from that shop. The two west run one hundred and forty-two miles, the other two east one hundred and four miles, over each respective division. These four freight engines averaged eight and twelve-hundredths pounds of water to one pound of coal, drawing thirty-five loaded cars in each train at an average speed of eighteen miles an hour. You must recollect on the Erie Road we have what is called a wide gauge, and our cars are very much heavier in every way than your narrow-gauge cars. Perhaps they will average anywhere from ten to fifteen per cent. heavier at least—I presume fifteen per cent. heavier. This trial was made by weighing the coal and also the water. The trial was carefully made for fourteen days in succession with those four engines, and I give you the result. We also took four passenger engines of thirty-eight tons each—our ordinary passenger engines running on our first-class trains. Those averaged six and seventy-five hundredths pounds of water to one pound of coal, drawing a train of nine and one-half cars at an average rate of speed of forty-three miles per hour; and I will venture to say that two of our cars will make at least two or three of the ordinary narrow-gauge cars, take the whole country through. They are very long and wide, and necessarily built very much heavier in proportion than the narrow-gauge cars. That is the result of the plain fire-boxes using bituminous coal. I have used the same arrangement that these gentlemen speak of—the fire-brick arch—and finally threw it away and came to the conclusion it was of no advantage. Then I have also used the deep combustion chamber that was introduced and thought to be a most excellent thing. I have used that as deep as four feet, reducing that down from time to time to six inches, thinking that was an advantage, and finally gave the whole thing up and put in the flue sheet the whole depth of the fire-box. Most of our master mechanics, I think, as a general thing, build fire-boxes with the flue sheet in two parts, thinking it necessary and that we can replace a flue sheet much easier putting it in in part than in whole. It is a mistaken notion, of course. Oftentimes, perhaps nine times out of ten, the sheet gives way at that seam before any other part of it gives out. The seam burns out, and we have to take out not only the top but the bottom part of it entirely, so I have adopted the usage of putting in a solid sheet from top to bottom or from bottom to top, to do away with that seam. I have given you the result of the plain fire-box. If any of you have a result in figures of any new plan of economizing fuel, I would like to have it, and I would like to have it in figures.

THE SECRETARY—Mr. Towne gives a comparison of the plain with that of the water leg in this report.

MR. TOWNE, Hannibal & St. Joseph Railroad—I will simply state, before that is read, that I believe the only thing that can be depended upon in this matter is this statement: A simple experiment with an engine for any par-

ticular number of miles on one occasion is no experiment at all. These experiments which are referred to, I think are taken from six months' trial, a careful record being kept, and it is substantially correct. I would state that the engines we used at that time were somewhat out of repair, but I don't regard it as any detriment to the use of coal in the plain box on that account. I have the Jauriet fire-box which is substantially the same thing as the brick arch. So far as my experience has gone, I think all our engines are doing very much better than any plain boxes we have ever used for bituminous coal. It may be that the plain box will do better on other roads than on ours; but that remains to be proven. We can only tell that by experiment. We are still using the Jauriet water leg with good results. We are running forty-three to forty-eight miles on a ton of coal, on the average, and our passenger engines run up to forty-eight and fifty. Our passenger trains are very heavy—six to nine cars—over a road that is very heavily graded. Our heaviest grades run up to ninety feet. We have had, up to within the last year, grades even heavier than that. Our passenger trains at present are lighter. We are running four to eight coaches and are making fifty to fifty-five miles to the ton of coal. I think the use of coal depends very much upon the manner of using it. Stoking is a very important matter in the use of coal. Good firemen, well drilled in firing, will make ten miles to the ton better than those who have no experience in firing engines. I have no doubt if you put a green fireman on one of our engines she will not do as well (in fact, I know it to be the case, by at least ten miles to the ton of coal) as with one that has been drilled in the use of coal. An engine will burn all the coal you put into her; that is, it will get rid of it in some way. The secret of firing is to keep the coal out of the engine. I believe an engine with the water leg will burn less than with the plain fire-box, because you have the advantage of the consumption of the gas. If there is any principle at all in what is called a base-burning stove, we have approached that somewhat in the use of the water leg or brick arch in the locomotive. If we get to it nearer we shall have a still better engine. Now I refer particularly to these experiments on the Hannibal & St. Joseph Road of the Jauriet water leg compared with the plain box. They were not experiments, but simply a record of the performances of the engines.

THE SECRETARY—I would like to inquire if, at the time those engines were changed from the plain fire-box to the water leg, there was not more or less work done upon the packing and valve gearing.

Mr. TOWNE, Hannibal & St. Joseph Railroad—Yes sir, there was; so also was the same amount of work done to the plain boxes. When the plain boxes needed the valves faced, of course it was done.

THE SECRETARY—I would like to ask Mr. Towne if he has not noticed it as a fact that when an engine's valves begin to blow, the engineer will run perhaps a week or two before reporting that his valves need facing; and when the engine is brought in and the valves faced, the engineer will say she burns

one-fourth or one-third less coal, or she don't burn half as much, and if he has not actually seen it make that difference in a little work on the packing and valves?

Mr. TOWNE, Hannibal & St. Joseph Railroad—Yes sir; no question about that. Keep your engines up; keep your packing good, and the valves faced you do better. So with long valves. Allow your motion to get out of order and your long valves are a detriment; but if you keep the motion up they are better than short valves. Our valves are none of them less than seven-eighths lap. Of course the motion must be maintained to get good results.

Mr. GREGG, Erie Railway—The gentleman suggests that my experiments were not fair, because it was only one engine at a time that we used. I said that we used four engines. There were four freight and four passenger engines taken, and they were used along from day to day for fourteen days in succession. I would also say that those engines were not put into the shop and put into condition for those experiments, but were taken indiscriminately from the mass of engines run on the road, without any preparation whatever or any extra pains taken to determine the matter other than to have a fair experiment with ordinary engines in ordinary use—nothing more.

Mr. PHILBRICK, Maine Central Railroad—I would like to ask Mr. Gregg the condition of the coal he used. I happen to be on a road a long ways from coal mines. We get our coal very fine. It appears to be the scrapings up of what they don't want in Pennsylvania, and we require the brick arch, I would like to ask if their coal is good, clean, coarse coal, or a fine coal.

Mr. GREGG, Erie Railway—I would answer that by stating that the coal we use is simply what we call the run of the mine. About one-third of that coal may be considered medium coal; the other two-thirds fine coal, or what we would regard as blacksmith's coal.

THE PRESIDENT—The coal used in this section is fine like meal, hardly enough lumps to start a fire with, and requires to be wet down to get it into the fire-box, and that is why they need the brick arch.

Mr. FORNEY, Railroad Gazette—I should like to inquire whether the size of the locomotive boilers has not more to do with the economical combustion of coal than the peculiar style of fire-box. I have noticed with a small boiler working very hard, when the fire must be forced to its extreme limit, that the coal is drawn over the grate, up the flues and out of the stack, and goes off unconsumed. So with the gas. The smoke has not time to be consumed. You have to force the fire too hard for consumption. If you take a train of thirty cars I think the engine with the largest boiler will show the most favorable consumption of coal. There is another feature about this. In running on a level road, if you have a large boiler and the boiler is not working up to its extreme limits, it is possible to fill it tolerably full of water—so in running up a grade you have a large amount of hot water to use in going up the grade; whereas, if it is a small boiler, you have to use it all up. I am

aware that on a heavy grade you can not depend much on the water, but it seems to me the advantage of a large boiler in this respect is a great advan tage. I would like to have the master mechanics give their expression i relation to this point—whether there is any limit to the size of boiler it advantageous to use. If you have a thirty-ton engine, there is, of course, limit beyond which you can not go without increasing the size of the engin but with such an engine, without that limit, can you have a boiler too la for the economical consumption of coal?

"Mr. Wells, of the Jeffersonville, Madison & Indianapolis Ra road, prefers the plain box, but advises an increase in size over th now in use on our standard engines. In his opinion the furna should be longer and deeper, the grate area being the same as no and, as a consequence, the steaming capacity of the boiler greater, that the gases need not be 'hurried' through the flues as is n done, but more time be allowed for combustion.

"He expresses the conviction that 'boilers of coal burners a as a class, too small,' and therefore do not burn coal economically

Mr. Towne, Hannibal & St. Joseph Railroad—In order to verify th statement I would say we have half a dozen engines, more or less, with forty-five-inch boiler, using the Jauriet fire-box, that run from thirty-two thirty-eight miles to a ton of coal, where our engines with a forty-eig inch boiler, doing the same service, are running forty-two to forty-five mi to the ton of coal.

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—I thi Mr. Gregg's statement verifies that. It seems the evaporation was great per pound of fuel in the freight engines, which I presume are larger th the passenger engines, than it was where the speed was high, and the eva oration necessarily must be rapid. Now we all know that freight engin run slower and the number of cubic feet of steam furnished per hour is le than passenger engines when they are worked up to their full capacity, an according to his statement, the difference in evaporation there was abo twenty per cent. in favor of the freight engines, and I can not see that the is any other reason than that it was slower and there was more time given.

Mr. Hudson, Rogers' Locomotive Works—I apprehend that there a other circumstances which would modify the results as to the different kin of furnaces than whether one had the Jauriet furnace and the other the plai furnace—the mode of admitting the air, the quantity of air admitted, th length of time before the gas reaches the tubes; because it is well known th if perfect combustion does not take place before the gases enter the tubes, i will not be completed afterward; therefore combustion must take place i

the furnace. Theoretically, the fire-brick arch is the best thing to accomplish that purpose, because it causes an eddy in the gases, and gives them more time to mix with the air and makes them run longer before they reach the tubes, and affords them a better opportunity for perfect combustion. On the contrary, the water-leg furnaces, like the Jauriet, while they give a longer run to the gases and do, to a certain extent, increase the economy of consumption—I have no doubt about that—at the same time they, to a certain extent, defeat the very object which the water leg is put in to serve, that is by absorbing heat which is necessary to the perfect union of the oxygen and gases. In other words, carbureted hydrogen must be of a certain temperature to unite with the air, or the carbon will be deposited in a solid state and go out in the shape of soot that adds nothing to the efficiency of the boiler. I should like to inquire if any member of this Convention has any knowledge of the practical operation of those furnaces on the Hudson River or the Cumberland Road. Theoretically the brick arch is the best calculated to fulfill the object in view, if the air is admitted properly. I might refer to an apparatus which is referred to in that report, a sort of chute put into the furnace door and bent downwards two feet or more. I was very much struck with the efficiency of that device. The doors are made to slide sideways. They are partly opened, air is admitted and is deflected downwards, rolls over and mixes with the gases and increases the time which the gases are in mixing with the air and in reaching the tubes giving a better opportunity for perfect combustion. After having seen the operation of this furnace and that chute with that peculiar kind of door in England, we were building some engines for South America, and Mr. E. P. Gould, formerly of the Jersey City Locomotive Works, was connected with the road, and I proposed to put on that apparatus and he consented; and he reports that it works remarkably well, and all the engines we have built for that country have that apparatus, and from the reports I hear from it it answers admirably for the purpose for which it is intended, and there is very little emission of smoke with highly bituminous coal.

Mr. SELLERS, late Des Moines Valley Railroad—Mr. Hudson has expressed my views entirely, but it is an established fact, established beyond controversy, that the reason we don't have perfect combustion is our exhaust draws our air through our fire so rapidly that perfect combustion can not ensue, and the only way to remedy that is to enlarge our grate surface and have a larger surface to pass through and let it pass through slower.

Mr. HILL, Erie Railway—Since those experiments made on the Erie Road, we have built four locomotives, eighteen by twenty-four inch cylinder, forty-three-ton engines with fire-boxes sixty-six by forty inches. I must say I was astonished to see the small quantity of fuel those engines consume. I don't think they burn two-thirds the fuel of some engines with the same size of cylinder. The air passes through slower and there is per-

fect combustion. In riding one hundred miles one will not see a particle of black smoke except when you are putting in fresh coal. The fire-boxes are sixty-six inches in length and forty inches high. The side rods are eight feet six inches.

Mr. HUDSON, Rogers' Locomotive Works—I would like to ask Mr. Hill if the Erie Road has not had some experience in burning bituminous coal in engines originally constructed for burning anthracite, with furnaces eight feet or more in length?

Mr. HILL, Erie Railway—We burned nearly a year bituminous coal in anthracite burners. It did very well. We could not find much fault, except the fire came so near the flues. It made them leak. We took one of them that was leaking and took the bituminous coal out and used anthracite, and it dried up, which shows that a deep fire-box is essential for bituminous coal. We use as deep for bituminous coal as we would for wood.

Mr. HUDSON, Rogers' Locomotive Works—The term narrow-gauge in contradistinction to the six-foot gauge, I presume does not imply the two-and-a-half or three-feet gauges, but the four feet eight and one-half inches, four feet ten inches, or five feet, because I think it is important that the report should not make that mistake—that it is narrower than ordinary gauge.

Mr. TOWNE, Hannibal & St. Joseph Railroad—There is no question at all about the advantage of the large boxes for burning coal. We always put in just as large as we can get them, and in some instances I have spread the drivers and put on new frames to get longer boxes. Burning the coal that we use in our country, we get better advantages with large boxes than with small ones. The only point is to confine the gases so they may be consumed. It requires three hundred thousand cubic feet of air to burn a ton of coal. We put in forty-eight to fifty one-inch air tubes in the Jauriet boxes, and then sometimes don't get air enough. If the air could be admitted regularly or at intervals when it is required, and stopped off when it is not required, it would be much better. I always have the coal broken to a certain size before being used; about an egg size is the best size for burning in the Jauriet box, or, I presume, in any other box. We run from three inches to four and one-half inches of coal on the grate. Sometimes it gets as high as eight on the freight engines. I have no doubt with closer firing we should get better results. If our boxes were twelve inches longer, I have no doubt we would get twenty per cent. better results.

Mr. SELLERS, of Pittsburgh—For a great many years we have been trying to burn our black smoke. We have tried to do it after distilling the smoke from the coal. It is a mistake to think that we can get perfect combustion after it has been distilled. You can partially, but you must precipitate the carbon and send it off in the shape of soot. The only way to get perfect combustion is to burn the gases as they are distilled, and the only way you can do that is to keep them in contact with the coal long enough to burn.

We have no doubt but some good is derived by using air blasts on the top of the smoke, but it is little good. We are looking after a will o' the wisp. We can never get perfect combustion after the coal has been distilled in the shape of black smoke. I say the only way is to have a large fire-box and pass your draft up slowly and burn it as it is distilled.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I have been using air tubes for a number of years, and I find a great advantage in using them, in the smoke. When you let the air in before it is too close to the flue sheet. It ignites the gas after it is up in the fire-box some distance; you can see it going on over this air opening and when you admit the air the gases blaze and there is combustion, and the question to be arrived at is as between the air opening above and the grate opening below. I have experimented to some extent to reduce the grate opening, and find there is a point in connection with those air openings above that gives the best results in combustion. The engine is freer from gases and freer from smoke. I think there is so little difference between the brick arch and plain fire-box it would hardly justify putting them in. I think our experience with forty engines, all of one class, with no prejudice, but giving the thing close observation, almost demonstrates the fact. They are large engines, well built, sixteen-inch cylinders, and they gave the result I spoke of. Some engines would do better with the arch and others again without; just the difference we all of us find in engines and can not account for. I admit with a small fire-box there may be some benefit from the brick arch; by carrying the gases round you get some advantage, but that is the whole advantage derived, I believe, from the arch.

Mr. FRY, Grand Trunk Railway—My experience corroborates certain facts mentioned by Mr. Elliott and Mr. Sellers. I had about eight years' experience on a railway in England under the superintendence of Mr. Cudworth, whose name stands very high as a successful coal-burning man. For two years I did scarcely anything else but run experiments with his engines. His fire-box is similar to that described by Mr. Sellers, a very large one—a fire-box that is deep near the tubes; but instead of having that depth back to the back part of the fire-box, he bring his bars level with the fire-box door. That enables the fireman, when burning a very bituminous coal, or a coal that is very fine and apt to run into slag, to put the slides down and stir it up, and by having it long—eight feet in length—he has a slow fire and gives the gases time to burn before they reach the tubes. The idea is, the coal is thrown on the front end of the fire, and as it burns it shakes down towards the lower part, where an intense white heat burned the gases before they reach the tubes. The fact that Mr. Elliott mentioned about the admission of air, we noticed, and introduced a sliding door to the grate, and whenever the driver saw smoke was being emitted, he pulled open the grate, and the admission of air checked the smoke. It was invariable and could

be seen at any moment, and when the smoke passed away, not to co he shut the grate again. The results obtained from these engines ways equal to, and we thought rather superior to, those obtained brick arch. I never run any experiments with the engines as again arch, because there were no brick arches when I joined the road. been used and been discarded. I was employed one summer to fin exact combustion for a mile and the number of pounds of water ev With careful firing, we could equal the result mentioned by M namely, eight pounds of water to a pound of fuel; and with the kind of coal, we could sometimes get nine pounds of water per fuel, and I would say that the consumption of smoke was always mu than upon those engines having a brick arch. In England much m tion has been paid to the consumption of smoke, owing to the large of towns passed through. Our line run through three towns in Lo was important that the smoke should be burned. If any smoke wa we were fined. We never adopted the brick arch, and our consu fuel was quite as good as any line using the brick arch, and we expense of it, and the danger of having the train stopped by h brick arch fall down, which frequently happened on other roads. a very careful series of experiments was instituted last year bet Cudworth fire-box and the Beattie fire-box. The trains took the sa ber of cars and they run the same train at the same rate of speed Cudworth without the brick arch gave to the consumption of fuel pound of water more. I have this from private and not from officia and could not vouch for its accuracy, but the fact of nine pounds un able circumstances and eight pounds under ordinary circumstan vouch for. The same number of cars were taken upon the same t same number of stops made; the coal was very carefully weighed water very carefully measured. I would say that the two great a that were considered to be gained were having the long box, so the be a slow combustion of the gases, and then the fact of being able air at the back end of the fire-box, and as our bars came up level fire-box door, it was impossible to put in the long scoop.

Mr. Forney, Railroad Gazette—I would like to inquire in rega length of the fire-box, and whether they had mid-feather and grate; whether they were fired on one side and then on the othe what extent that influenced the combustion?

Mr. Fry, Grand Trunk Railroad—The idea was in designing the they should be fired alternately, and a mid-feather was run from end of the fire-box almost to the tube sheet, and the intention was should fire alternately; but it was found that with a fire-box seven f inches inside length, the consumption was so good that it was un and the firemen fired both.

Mr. FORNEY, Railroad Gazette—Could the same effects be produced without the mid-feather?

Mr. FRY, Grand Trunk Railroad—I don't know. We always thought the same effects could be produced without it. I have seen engines without it on the Chatham & Dover Railway; but the engines did not have exactly the same design. The fire-bars did not come flush with the door. One foot in seven was the slope. I believe in the engraving the slope is rather more; but that is the standard.

Mr. FORNEY, Railroad Gazette—With the working of the engine did the coal work forward?

Mr. FRY, Grand Trunk Railroad—Oh, yes; we always found that it worked forward.

Mr. FORNEY, Railroad Gazette—Was it necessary to push it forward with a poker?

Mr. FRY, Grand Trunk Railroad—Never with a poker unless it was clinked, and then only once or twice on a journey. The operation of fusing was to run a shovel in underneath and lift it up, and then throw loose coal on top. We always noticed that the difficulty was to get good firemen; not but anybody could fire easily, but it was difficult to get men to come up to the standard of our best men. We found a great difference in the results obtained by different men on the engines.

Mr. ROBINSON, Great Western Railway, of Canada—Mr. Fry brings to my mind a large number of experiments which I witnessed, with different shaped fire-boxes, when in England. Having studied my business on the London & North-western Railway of England, I happened to be on hand when a series of experiments in this connection were going on. At that time, now seventeen years ago, fire-boxes were made and altered into every conceivable shape for these experimental purposes, and any one interested in the subject who may have been on English railroads during that period will remember with amusement how much money was spent in getting up and destroying the various devices. No expense was apparently spared to test the important subject. Fire-boxes were widened at the bottom, and water partitions were introduced in every conceivable shape. Mr. Cudworth's long, inclined fire-boxes, mentioned by Mr. Fry, were adopted on some roads in various ways. On the road I was connected with, among the many peculiar positions of fire-boxes tested, one was tried with the boxes laid like a staircase or steps, inclining from the fire-door to the tube sheet. The notion in this form of grate is, that the green coal should be supplied at the highest end and be shaken down by the motion of the engine; but notwithstanding the inclination of the grate, it was found that the soft coal, especially if small, became cemented together, and had to be broken by a poker or iron bar and pushed down, which duty by degrees became neglected by the firemen, and thus unsatisfactory results were the consequence of it. Mr. McConnell, London & North-

western Railway, introduced longitudinal water partitions down th the fire-box and extended the fire-box into about one-quarter the the barrel; the intention being that the firemen should fire each s partition through two independent fire holes alternately, and that c should take place in the chamber in the barrel of the boiler. M London & South-western Railway, tried similar plans with the adc complicated arrangement of bricks. Mr. D. K. Clarke used ho bolts above the level of the fire and forced air into the furnace by jets of steam from the outside, in the manner of a series of air All these, and many other plans of lesser note, I lived in Eng enough to see abandoned, after obtaining more or less good result from seven to ten pounds of water evaporated per pound of fuel, to state of engine. But the greater value of simplicity of wearing coming apparent as these experiments progressed, they were repla generally by the simple old form of fire-box, in which was introdu the brick arch under the tubes, or a deflecting plate through the and in some cases both are used with good results. In connection a blower in the smoke-stack is used to help, when in towns or citi sume the smoke which, with the other combined appliances, is gen cessfully accomplished. Mr. Ramsbottom, late of London & Nor Railway, placed the brick arch inclining downwards toward the fi wards, and admitted the air in special air doors under the brick arc the fire-box plates under tube sheet. This plan, I believe, works factorily, both in economy of fuel and consumption of smoke. Al years ago, the engines under my care were necessarily supplied green wood that I had to resort to coal, which caused me to renew ries upon the subject, when I got up plans and made what might b "hot air leg," to be used similarly to the brick arch or water leg. made of cast iron, hollow, like a water leg, and perforated on the u At the lower end under the tube sheet, were holes corresponding w holes through large hollow stay-bolts or tubes, through which tl admitted under the barrel of the boiler and regulated by a slide wo the foot-plate. It so happened that just as these plans were perfec supply of dry wood was again furnished and coal abandoned, ren experiments useless so far as my road was concerned, for the time l should the idea meet with the approval of any of our members, I state that it is entirely free and at their disposal; and feeling that it has merit worthy of further investigation, I hope those usin will give it some consideration.

The third question was read and, on motion of the Secretary, until the report of the Committee on Straight and Wagon Top Boil be received.

Mr. HAYES, Illinois Central Railroad—It seems to me that thes

jects were complicated. As I understand it we were a Committee on Boilers and Boiler Materials. Now, *boilers* includes all kinds of boilers, and I supposed we were to cover that ground; hence I see no need of another committee on straight and wagon top boilers. If we were a Committee on Boilers and Boiler Materials, I should suppose we were to take in all kinds of boilers with which railroad mechanics are familiar, both stationary and locomotive.

THE SECRETARY—The subjects and committees all came to me just as they were given, and it was suggested to the President that some of the subjects might, perhaps, conflict a little; but he did not feel as though we ought to alter the arrangement at all, and it was not done.

The next question was read by the Secretary, as follows:

"What diameter of flues do you advise for use in wood and coal-burning engines?"

Mr. ELLIOTT, Ohio & Mississippi Railroad—Mr. Peddle has had some experience with two-and-one-quarter-inch flues, and I would like to hear from him on this subject.

Mr. PEDDLE, Indianapolis, Terre Haute & St. Louis Railroad—I would state that the experience I have had with a certain kind of coal is in favor of the two-and-one-quarter as against the two-inch tubes. With the soft coal we get in Illinois, we find great difficulty in using two-inch tubes; but with the block coal, which burns freely and which we get in Indiana, we have no trouble. Taking the sum of all the experience I have had, I am in favor of the two-and-one-quarter inch tubes for coal.

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—I wish to call the attention of the Association to the recommendation of the President for the appointment of a committee to whom subjects for future discussion may be referred, that they may be able to report early. I move that a committee of five be appointed to select subjects for the next annual meeting.

Agreed to, and the committee appointed as follows: Boon, Pittsburgh, Fort Wayne & Chicago Railroad; Forney, of the Railroad Gazette; Perrin, Taunton Locomotive Works; Robinson, Great Western Railway; Smith, South Carolina Railroad.

Mr. FLYNN, Western and Atlantic Railroad—I would like to suggest to that committee a subject of inquiry which would be of interest to us, and that is, the economy of the use of coal as against wood. In some portions of the South, before long, we shall be compelled to use coal, and it would be an interesting subject of inquiry to us to know what price wood should reach to make the use of coal more economical.

Adjourned to nine o'clock, June 12.

SECOND DAY.

The Association was called to order at 9:20 A. M., Wednesday, Jun by the President, and the discussion upon the report of the Committe Boilers and Boiler Materials was resumed.

The eighth question, "Do you advise drilling instead of punching rivet holes in boiler plate?"

Mr. HAYES, Illinois Central Railroad—The Committee found that were a great many master mechanics who said that they believed drilling better than punching, but they had made no experiments. Hence the (mittee were in the dark upon the subject, and made a series of experin in order to get light, the results of which are embodied in the report.

By request, the Secretary read the portion of the report referred t follows:

"A large majority of master mechanics from whom we have h advise drilling instead of punching rivet holes in boiler plate. tests of their relative strengths were reported, and your Commi therefore, felt compelled to experiment in order that definite in mation might be given you.

"The following tests were made, all the pieces being from the sheet:

"Three pieces of $\frac{5}{16}$ inch boiler plate, $1\frac{3}{4}$ inches wide, were to two by hydraulic pressure:

No. 1 broke under a strain of				32,228 lbs
" 2	"	"	"	32,228 "
" 3	"	"	"	33,600 "
The average breaking strain being				32,685 "

"Three pieces of $\frac{5}{16} \times 1\frac{3}{4}$ inch plate were *punched*, one $\frac{5}{8}$ inch being put in each piece. They were then subjected to a te strain, with the following result:

No. 1 broke under a pressure of				13,371 lbs
" 2	"	"	"	13,371 "
" 3	"	"	"	13,714 "
The average being				13,485 "

"Three pieces of $\frac{5}{16} \times 1\frac{3}{4}$ inch plate were *drilled*, one $\frac{5}{8}$ inch hole being put in each piece:

No. 1 broke under a pressure of	17,828 lbs.
" 2 " " "	17,485 "
" 3 " " "	17,622 "
The average being	17,645 "

"The average strength of the drilled plate being 4,160 lbs. greater than that of the punched plate.

"Great care was taken to dress the pieces to the sizes given after they were punched or drilled.

"The following comparative tests were then made with punched and drilled plates riveted:

"Six pieces $1\frac{3}{4}$ inches wide, and cut from the same sheet as the foregoing, were punched and riveted together, in pairs, with the best $\frac{5}{8}$ inch rivets, one rivet to each pair, and were subjected to a tensile strain, with the following result:

No. 1 broke in center line of hole under	17,828 lbs.
" 2 " " " "	17,828 "
" 3 " " " "	17 143 "
The average breaking strain being	17,599 "

"Six pieces, duplicates of those last mentioned, were *drilled*, and riveted together in pairs, one $\frac{5}{8}$ inch rivet to each pair:

No. 1 sheared the rivet under a pressure of	17,143 lbs.
" 2 " " " "	16,457 "
" 3 " " " "	15,428 "
The average shearing strain being	16,342 "

"You will observe that the rivets securing the plates having drilled holes, were sheared under a less pressure than was required to tear asunder the plates having punched holes.

"It is also worthy of note that, while the punched plate is weaker than the drilled plate, the rivets in the punched holes do not shear so easily as those in the drilled holes. This is probably due to the edges of the drilled holes being sharper and more compact, and consequently more capable of shearing than the edges left by a punch. It is not probable that the tensile strength of boiler plate, per square

inch of section, is impaired by drilling, but your Committee are sa fied it is impaired by the use of a punch.

"In view of these facts we advise drilling the rivet holes for lon tudinal seams of boilers; the circular seams are not subject to great a strain and may be punched. We also advise the use of inch rivets, $1\frac{7}{8}$ inches from center to center, for all seams in locon tive boilers made of $\frac{5}{16}$ inch iron, as the $\frac{5}{8}$ inch rivet is too small resist a shearing strain equal to the tensile strength of the plate tween the rivet holes when they are drilled."

Mr. Robinson, Great Western Railway—I would like to ask Mr. Ha whether the gentlemen who made these experiments formed any opinion made any estimate as to the difference in cost between drilling and punch the holes in manufacturing a locomotive boiler?

Mr. Hayes, Illinois Central Railroad—There was no estimate made of cost, but Mr. Robinson and every other master mechanic can very ea judge what the difference would be. A man could probably punch th holes while he is drilling one. But the number of holes we recommen be drilled in a boiler is not very large, and hence the increase in the cos the boiler would not exceed twenty-five dollars.

Mr. Forney, Railroad Gazette—It seems to me that if the conclus to which the Committee have arrived is correct, that the strength of punched portion of a boiler plate is thirty per cent. stronger if it is dril than it is if the holes are punched, it is an extremely important fact, and to which a great deal of attention should be paid. I know that many h doubted whether there is so great a difference as the Committee state. merely wish to impress upon master mechanics the importance of paying attention to this fact. It was stated here yesterday that in England the b er-makers had abandoned drilling boiler plates. I happen to have here specifications of some engines that were built in England, from which I w read an extract: "The longitudinal seams are all double-riveted, with t strips inside and out, the latter being countersunk to enable the rivets to the holes well up. * * * *All the holes in the boilers are drilled*, and all edges of the plates planed." It appears, therefore, that in some establi ments in England, at any rate, they are still drilling boiler plates, and se to realize the importance of doing so.

Mr. Hudson, Rogers' Locomotive Works—I think the question of drill or punching plates hinges rather upon some other considerations than mer the relative strength of drilled and punched plates. We want to know facts in regard to boiler explosions, and where the sheets generally give w Do they give way tearing from hole to hole, or do they give way on what

ordinarily call the caulking edge? My own impression is, from the opportunities I have had to examine boilers that have exploded, that they rarely tear apart from hole to hole, but that the sheets gradually give way or break at the caulking edge from the bending backward and forward of the sheet from time to time as the boiler is under strain. In one or two cases I found in a length of twenty-four inches—taking it along the caulking edge, in a direct line—that there was not three inches of solid iron left. We have avoided that difficulty, in constructing our boilers, by putting a welt piece around, lapping it on the inside, extending over the edges of the sheet in each direction—the direction of the caulking edge and the other edge. The rivets go through this additional piece, and are staggered on each side, this additional piece being thinned at the edges, so as to make the strain gradually die away, and not be concentrated on the caulking edge. If neither punched nor drilled plates give way through the holes, then it is not a question whether it is better to drill or to punch them, because, if they do not give way there, it is an immaterial matter; but the question is, the strength of the boiler where it gives way.

Mr. GREGG, Erie Railway—The experiments which have been made are evidently very important to us, as master mechanics, but I think they have not gone quite far enough. If I understand the experiments, they have proven very clearly that the drilled sheet is the stronger of the two; that is, the drilled sheets stand the heaviest tensile strain, by several thousand pounds; but, at the same time, they show that the rivets shear in the drilled sheets under a much lighter strain than the plates break of the punched sheets; showing that, if put together with the same size of rivets, the drilled sheet is really much the weaker sheet. The experiments, perhaps, have not been continued far enough to determine what increased size of rivet the drilled sheet would stand, as compared with the punched sheet, and how much greater strain the drilled sheet would stand when the rivets were increased in proportion to the strength of the sheet, as compared with the punched sheet. When that point is determined, it will be seen how important it is to drill sheets instead of punching them. It will increase the expense to drill rather than punch. I am very glad to know that these experiments have been carried so far, but it seems to me, as I have said, that they have not been carried far enough, since that fact has not been decided.

Mr. FORNEY, Railroad Gazette—In regard to what has been stated by Mr. Hudson, his experience and observation have been very much more extensive than my own, and therefore much more worthy of weight than what I have observed; but my experience and observation have shown that more boilers give way through rivet holes than along the line of the seam. But even supposing what he states to be correct, by using a covering plate or welt piece, you obviate that difficulty of the bending of the sheet close up to the caulking seam. If that difficulty is obviated, it would seem to indicate that

a boiler must be a great deal stronger if you drill the plates. Th people, as I have seen from books (and probably there are some here who have had experience on the other side), who are maki many boilers, butt the joints, by putting a covering plate inside ar outside, so that there will be no tendency to bend the sheet close to ing seam. The danger from that cause of rupture is in that wa Therefore, if you drill the plates, the strength of the seam mus much increased. There is another feature in regard to the drilling which seems to me very important, and that is matching the holes of us know that in ordinary boiler work it is extremely difficult to holes, when they are punched, meet accurately. They will vary second or even a sixteenth of an inch. The result is, it is almost i to make the rivet fill up the hole, and consequently an undue s come upon some of the rivets, while upon others there will be strain. In that case there is danger of shearing off the rivet up the extra strain comes, and bringing a strain upon the adjoining l thus starting a rupture which will ultimately result in the destruct boiler. Now, in drilling plates, the holes can be made to match the plates are drilled together, and therefore each rivet will do its portion of the work and no greater strain will be thrown upon one others. I think that careful experiments in regard to this matter extremely interesting and valuable. I suppose there is hardly a this body who has not had occasion to see the dreadfully disastro which have followed from boiler explosions. In considering th therefore, we are not merely looking to the saving of money to t who employ us, but to the saving of human life; therefore we ough to give great attention and due weight to all facts and experimen upon this question. In the discussion yesterday nothing was said to the quality of the material used in the stays. I am very wel that the reason why stays and braces so frequently give way in boil poor material is used in that portion of the boiler which should h ably, as good material as any other portion, and perhaps better.

Mr. HAYES, Illinois Central Railroad—The subject of stays is in the report, and, of course, will be brought up in due time. A believe it is not contained in the question, I may state now that in mentioned in that report, in examining an old boiler we found bolts broken off, pretty much in the same place, near the top of th Ascertaining that we were liable to have explosions from that caus experimented somewhat upon this question of stay-bolts, and put of our investigations into the report.

Mr. BROWN, Erie Railway—Is not the fact of the rivets, in puncl resisting a greater strain than those in drilled sheets due to the fi the punched sheets you change the plane of the surface iron, and

the rivets the imperfections are driven into each other, thereby resisting greater strain?

Mr. PHILBRICK, Maine Central Railroad—As to the question where boilers give way, my experience is not large; but I have examined several cases carefully, and in examining a case of explosion I think I have generally been able to detect the first starting point, and then the successive ruptures as they went on. I do not know that I ever found a rupture to start in sound iron around the rivets. I have found them to break through the rivets afterwards, evidently, but they started at some other point—either the caulking edge or some other point—the rupture then continuing through the seams and breaking between the rivets; but had that weak point not occurred there I have no reason to suppose it would have broken through the sound riveting. So far as I have been able to judge the starting point of ruptures is generally quite a weak point. They are caused by the spring, on account of the vibration, or by the unequaled expansion, carrying one by the other, so as to weaken it until it gives way. Generally it is quite thin. From that point you can't tell where it will go.

Mr. HAYES, Illinois Central Railroad—We all know that a riveted seam is only about fifty-six per cent. of the full strength of the iron. Now, if we know that we have a weak point there, a point that has only fifty-six per cent. of the strength of the balance of the boiler, why do something to make that weak point still weaker? Why not do something to make it stronger? In drilling sheets, using rivets of the proper size, and putting them at a proper distance apart, are we not doing a benefit to the public and to the railroad world? If we can do anything that will save expense upon railroads, save lives, and make our boilers last longer, is it not better for us to do it? We all know that the seam of a boiler is its weakest point, and hence anything that we can do to strengthen that weak point is an advantage.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I think Mr. Hayes has hit the exact point to which we should give particular attention. The experiments of the Committee seem to have demonstrated that we gain, by drilling the seam of a boiler longitudinally, about thirty per cent. Certainly that is something to gain. Now the strain that a rivet shears at is very near the strain at which drilled sheets pull apart, and therefore, by drilling the longitudinal seams, we gain an amount of strength equal to the strength before the rivets in a punched sheet gives way, beyond the strength of the sheet, therefore there is a point demonstrated by these experiments that is worthy of consideration. It is of little consequence for us to know why a rivet will shear quicker with a drilled sheet than it will with a punched sheet, in comparison with the other fact that by drilling our sheets we gain thirty per cent. of strength.

Mr. HUDSON, Rogers' Locomotive Works—While I agree, generally, with the idea that it is very important to make boilers as strong as they can be

made in every way, still I think, as I said before, that we want to look f the weakest point first. We do not want to look for that point which is n the cause of boiler explosions. I do not wish to be understood as statin that it is better to punch plates than to drill them; but I do wish to stat that I think the difference between punching and drilling will not material tend to prevent boilers giving way. They do not give way, as I have sai in my experience, through the rivet holes, nor from the shearing of tl rivets. The giving way commences, in the first place, at the weakest poi of the boiler, wherever that may be, and we may generally look for th weakest point where the laps are, and in the neighborhood of those lap That the strain may be intensified by injudiciously staying some oth part of the boiler, causing undue working and throwing an undue strain up that point, I have no doubt; but I have no hesitation in saying that I ha generally been able to detect, in the boiler explosions that I have had opportunity to examine, where the boiler commenced to give way; and, must say, that I never found a case where the appearances indicated that gave way through the rivet holes first, but always in the neighborhood the termination of the laps, either at the caulking edge or the other edge the sheet; therefore I think it is important that we should understand tl the great point is to strengthen the weakest part of the boiler. Is the we ness due to the punching, or would it materially strengthen this portion the sheet, in the neighborhood of the caulking edge, to drill the holes? so, then let us drill them; but I can not see that it would make any mate difference in that respect; and therefore I say, while I have no objection drilling—it is simply a question of cost—it appears to me that doing t would not materially strengthen the boiler. If the boiler gives way throu the rivet holes, owing to the increased strain brought upon the iron fr the punching, then it is important to drill; but, according to my experien such is not the fact.

Mr. PHILBRICK, Maine Central Railroad—Will the gentleman tell us ab what proportion of the iron sheet gives way, according to his experience the time of explosion? About how thin has the iron become before givi way at the time of the explosion?

Mr. HUDSON, Rogers' Locomotive Works—In those cases that I ha examined, not one-quarter of the iron has remained in the condition which it was originally; that is, with regard to its thickness, or with gard to its freedom from cracks, and being broken by being bent backw and forward. In some cases this weakening is caused by what is cal "furrowing." If the laps or seams are below the water, and this stra ing takes place, then chemical action eats away the iron and you h a thin place there, and of course an additional bending takes place, beca we all know that these vibrations and changes occur at the place where th is a difference in section—the increase or diminution of the vibrations ta

place there. I say, therefore, that these are the points we want to strengthen. It would be far better, I think, if we could get cylindrical pieces made, as tires are, for the cylinder parts of boilers, without any seams at all, except the round seams, because we should then have no part weaker than the other; but in the absence of these, we want to do the best we can, and hence we want to make the best laps we can. I believe the English practice of making butt joints in the cylinder part, and putting a welt piece on the inside and outside, so as to have a perfect cylinder, is better in some respects than our practice, because it gives strength to the iron in the direction in which the strain upon the boilers does not tend to bend it backward and forward. It then depends upon the holding rivets, upon these welt pieces, and how tightly they are drawn together, and what shearing strain is brought upon the rivets. We very rarely hear of boilers giving way through the rivet holes. I was in England a year or two ago, and had an opportunity to examine several boilers that had exploded, and I find it was owing to furrowing. But that furrowing rather indicates that there must have been some disposition to yield in the sheets. The sheets were put together in the manner of which Mr. Forney has spoken, and the furrowing took place in these sheets on a line with the welt piece, and hence that became the weakest part.

Mr. Hayes, Illinois Central Railroad—Supposing you have a boiler, with a cylinder of any given length, and stay the heads so you are sure they will not give way, and rivet the seams longitudinally, in the ordinary manner, and subject it to hydraulic pressure, where will it give way?

Mr. Hudson, Rogers' Locomotive Works—If the ends are properly stayed it will give way about the center of the length.

Mr. Hayes, Illinois Central Railroad—I mean will it give way at the seam or in the solid part of the iron?

Mr. Hudson, Rogers' Locomotive Works—As I said before, if the seam is what we term a large lap—a turned seam—if it gives way at the edge of the lap, it gives way through the seam; but that is not through the smallest section of the iron.

Mr. Fry, Grand Trunk Railway—I think we are not treating our Committee fairly. As I understand it, they were asked to report upon the relative merits of drilling holes and punching them; they were not asked to determine in what way explosions take place. Nobody can doubt that it is an advantage to have our boilers equally strong in every part. If we make our boilers as strong as they can be made, and then find that they burst from injudicious staying, we may carry the experiment further, and find out whether there is not some better means of staying than we now practice. I think our discussion should be kept strictly to this point, whether a drilled or a punched boiler is the strongest; and then, thanking our Committee for the very careful experiments they have carried on, possibly we may request them to go further and inquire whether the cylindrical boilers spoken of by Mr. Forney are any better than the lap-joints in use.

THE PRESIDENT—I think Mr. Fry is quite right. In all our discussio we should confine ourselves to the questions and answers of the Committe

Mr. BROWN, Erie Railway—I think our Committee deserve great cre for the experiments they have gone into. They have demonstrated that drilled plate is thirty per cent. stronger than a punched plate. One of t members has suggested that they have not gone far enough. They have giv us a rule by which we can all work. Take thirty per cent. of the increas strength of the punched plate and add it to the strength of the rivet, and y increase the maximum strength of the boiler seams to over seventy per ce of that of the plates.

Mr. HUDSON, Rogers' Locomotive Works—I did not wish to throw a discredit upon the report of the Committee; I appreciate their labors highly as anybody else. I merely wish to draw attention to the real fa in the case. I do not want that we should deceive ourselves.

Mr. FORNEY, Railroad Gazette—I am not quite ready to abandon the i that boilers do frequently give way through the rivet holes. I happen now recall a case, which was not a boiler explosion, but an explosion of an air re voir, which blew the head off, and tore through the entire seam, all the w round. It broke through, I think, between every single rivet hole in that sea I also recall a boiler which I examined the other day in Hartford, with friend, Mr. Little. That had exploded, and I think nearly every rivet hole the circular seam next the smoke-box was broken through. It was also bro through the solid sheet in several places, but the greater part of the break was through the rivet holes. Many gentlemen here present, of course, h had opportunities for observation in this matter much more extensive t my own, and it would be extremely interesting and very valuable if we co learn accurate facts in regard to this point. I have no doubt that boilers frequently give way owing to the bending of the iron next the caulking sea but, as Mr. Hudson's opportunities for observation on these points have b much greater than my own, his testimony, is of course, the most valuable.

Mr. SETCHEL, Little Miami Railroad—I desire merely to add my testimo to Mr. Hudson's, in regard to the explosion of boilers. I have never yet s an exploded boiler where the appearances indicated that the rupture cc menced on the rivet line. We had five new boilers come on the road ab the same time, and in less than three months one of them exploded. It ga way where the wagon-top joined the side sheets by this working at the l I examined it soon after it gave way, and could see that the iron had cor ded so that there was not one-quarter of it holding when it gave way. was then thought best to make an examination of the others; and as stea had been noticed coming out round the wagon-top of one of them, we to that engine first, took the jacket off the wagon-top, and fired the engine u and a gentle tap of the hammer started a crack in that boiler of at least t inches long in the same place. We took the whole five in, and there was r

one that had not started in that seam. There was a long connection sheet from the wagon-top to the cylinder part of boiler, and no tie-rods, and the working had broken the metal off so that it exploded. All the boilers that I have ever seen give way, especially in the cylinder part, gave way at the edge of the seams first.

Mr. GORMAN, Toledo, Wabash & Western Railway—In speaking of boiler explosions, it seems to me we are losing sight of the fact that there are two kinds of ruptures that we call explosions. They all seem to be explosions; but I do not think one out of ten of the boilers that give way can properly be called explosions. There is as much difference between the explosion and bursting of a boiler as there is between day and night. There is a *bursting*, and an *explosion*.

Mr. TOWNE, Hannibal & St. Joseph Railroad—I would like to inquire of Mr. Setchel how those boilers were fastened to the frame, whether rigidly, or with an expansion piece, so as to allow the boiler to work?

Mr. SETCHEL, Little Miami Railroad—The boilers were not fastened to the frame.

Mr. ROBINSON, Great Western Railway—I think we are wandering from the subject. There is a paper with questions and answers on the subject of boiler explosions; we can burst out there, if we want to burst. But the subject in hand is the relative merits of punching holes and drilling them. I think Mr. Hayes has hit the right point. The question is, if you take a new boiler and fill it full of water, and put on the force pump, where will it burst? I think any one will find that longitudinal seams are very much inferior in strength to circular seams; therefore, I for one thank the Committee most heartily for the experiments they have made in this matter, and I feel relieved myself, because I have thought that drilling a boiler all over was the best plan. If we can arrive at the best result by simply drilling the longitudinal seams, we save half the labor. We know that in England they are making butt joints. The last time I was there, I found they were welding the longitudinal seams. That, to my mind, is a perfect boiler. The closest approach to welding is undoubtedly drilling the plates, and making butt joints with a strip inside and outside the sheet. That is the nearest approach to a welded boiler. If we can not afford to do that, the next best thing is to drill the holes, and make them as we do now. There are four steps. The first step is to punch the holes and lap them. The next is to drill the holes. The next is to place them joint to joint, still drilling the holes. The next step is to weld the sheets. This is a matter of opinion, after all. We shall probably go home—I shall, at any rate—and chew it over as a cow does her cud—think the matter over until we are satisfied as to the best method to be adopted. It is almost a purely scientific point. I think we should all thank the Committee for what they have done, and be more inclined than otherwise to accept their experiments as the guiding points of our opinion in this matter.

On motion of Mr. Philbrick, Maine Central Railroad, the next ques (10th) was then taken up.

"10th. Please state the material and thickness of the thinnest fi and back flue sheets you have used with safety in boilers of c burning locomotives."

The answer of the Committee is:

"We think back flue sheets should be $\frac{1}{2}$ inch thick if of iron, $\frac{7}{16}$ inch thick if of steel; front flue sheets $\frac{7}{16}$ thick if of iron, $\frac{3}{8}$ inch thick if of steel."

Mr. ELLIOTT, Ohio & Mississippi Railroad—I would like to state that ideas are just the reverse as regards thickness. I have been using tl eighths steel sheet for the fire-box sheet, and half inch for the front she order to give stiffness and withstand the caulking of the flues.

On motion of Mr. Keeler, Flint & Pere Marquette Railroad, the question and answer was read.

"11th. Can you suggest any advantageous changes in materia the construction of locomotive boilers?"

"In the various communications received from master mechanic changes of importance were suggested in the material or construc of locomotive boilers.

"Your Committee have one recommendation to make, and th in regard to stay-bolts for locomotive furnaces. We strongly the advisability of using hollow stay-bolt iron exclusively, so if a stay-bolt breaks partly or entirely, it will be discovered mediately.

"The objection may be made that too much cold air will be ad ted in the furnace. This, however, can be readily avoided by dri suitable plugs into the inner end of the holes in stay-bolts. A b recently examined was found to have 40 broken stay-bolts. boiler is $2\frac{1}{2}$ years old, and is stayed with $\frac{7}{8}$ inch bolts, $4\frac{1}{2}$ inches f center to center. Another boiler was found to have 15 stay-l broken.

"Similar instances are numerous, and we think safety demands a surer way of detecting broken stay-bolts than that of getting in

furnace and sounding with a hammer. An examination of this kind is rarely made unless an engine is in the shop for repairs; and consequently boilers often run in an unsafe condition, on account of hidden defects of this character.

"The remedy we suggest is thoroughly reliable. In order that you might have definite information of the strength of $\frac{7}{8}$ inch hollow stay-bolt iron, your Committee tested the tensile strength of three pieces. The hole through the center was $\frac{5}{16}$ inch diameter and the sectional area of the metal $\frac{52}{100}$ of a square inch:

No. 1 broke under pressure of	28,457 lbs.
" 2 " " "	29,828 "
" 3 " " "	30,171 "
The average being	29,485 "

"By experiments made a year ago, and submitted to this Association, we found that $\frac{7}{8}$ inch stay-bolts tapped into $\frac{5}{16}$ inch plates and riveted over, pulled out under an average pressure of 21,486 pounds, which is 8,000 pounds less than the tensile strength of $\frac{7}{8}$ inch hollow stay-bolt iron.

"It is certain therefore that the strength of $\frac{7}{8}$ inch hollow stay-bolts is more than sufficient to resist the strains to which they will be subjected, if placed $4\frac{1}{2}$ inches from center to center."

Mr. Eddy, Boston & Albany Railroad—I like the idea very much of putting in the hollow stay-bolts. I simply rise to ask one question: Why it would not be better to plug them outside rather than inside, because if they break then it would simply blow the water inside the fire-box and put out the fire; whereas, if they blew outside, when people are standing round, as they often are, it would be likely to do damage.

Mr. Little, of Philadelphia—Why would it not be better, instead of plugging, to use the plan that has been adopted by the Messrs. Day, in Philadelphia, in putting in their stay-bolts? That is, having small holes through the stay-bolt, and in riveting it over close that aperture almost entirely.

Mr. Elliott, Ohio & Mississippi Railroad—I would like to state some little experience I have had the last two years in the use of stay-bolts. We have changed the gauge on our road, and we had, of course, to change a great many engines. We had a number of them two and a half years old, and in getting out the stay-bolts we found we could knock out the inch tubes—those hollow stay-bolt tubes, an inch in diameter—very much easier than we could the seven-eighths stay-bolts. They were all sound (the engines had been

running and in pretty heavy service), but it took very little to break them s as to get the sheets apart.

Mr. Hudson, Rogers' Locomotive Works—I apprehend the question c hollow stay-bolts hinges somewhat upon how the hollow stay-bolts are mad So far as my experience goes, we have tried two ways, and out of those tw ways we only find one reliable. In other words, hollow stay-bolts made i the shape of tubes, we do not find reliable, because they are made by two o three thicknesses, one drawn over the other, and they are not always perfectl welded. We have had occasions where we could strip them apart, take o the outside and break it in two, and break the other apart, showing that th strength of that stay-bolt was merely the section on the outside. We fin that the only reliable way to make hollow stay-bolts is to drill them out. would like to know if there is any better way, because it is a great deal c trouble and quite expensive to drill them.

Mr. Elliott, Ohio & Mississippi Railroad—I move that the thanks of th Convention be tendered to the Committee on Boilers and Boiler Material f the excellent report they have furnished us.

This motion was adopted, and the next report taken up.

THE RELATIVE MERIT OF THE STRAIGHT AN WAGON-TOP BOILERS.

To the American Railway Master Mechanics' Association:

Gentlemen—The Committee appointed by you on the "Relat Merits of the Straight and Wagon-top Boilers," report as follows

We have received answers to questions in circular from twenty- master mechanics out of about three hundred sent out.

Answers are as follows:

Nineteen prefer the wagon-top boiler;

Seven prefer the straight boiler;

Nine report having boiler cracked over wagon-top;

Fourteen report had no boiler give way over wagon-top;

Nine report having straight boiler give way over fire-box;

Twenty report a preference for one dome, with throttle in sa over fire-box;

Six report a preference for two domes, placing the throttle in dom near smoke-stack.

In all cases where boilers give way in seams or otherwise over th fire-box of either straight or wagon top boilers, they attribute th

cause of same to faulty boiler staying, more so than to poor materials. Some report poor workmanship as well as materials, while others give no cause. Nearly all report the iron five-sixteenths thick where given out.

Those preferring the wagon-top boiler give their preference because they carry water better, have more steam room, and can get more heating surface than in the straight boiler.

Those preferring the straight boiler give their preference because they think them the stronger boiler.

The majority of those reported prefer the dome over the crown sheet on wagon-top boilers, claiming as an advantage that they get dryer steam and carry the water better.

Those who report a preference for two domes advocate taking steam from both, as they will take steam more evenly, and cause less rise in the water.

We hope to hear the experience of the Convention more fully on this subject, as out of the many roads so few have reported. All of which is respectfully submitted to the Association.

Very truly yours,

WM. H. GRIGGS,
J. I. KINSEY, } *Committee.*

The Committee submitted with their report the following letter from Mr. H. A. Towne, Hannibal & St. Joseph Railroad:

LETTER OF MR. H. A. TOWNE.

HANNIBAL, Missouri.

Messrs. Gregg and Kinsey, Committee on The Relative Merits of the Straight and Wagon-top Locomotive Boilers.

GENTLEMEN—Replying to your questions on the above subject, the writer will state that his own experience would lead him to consider the wagon-top decidedly the best. To reach anything near an elucidation of a subject involving so much detail, would require more time and attention than his official duties will at this time permit. He will, therefore, only refer to some facts and figures in connection with the subject. In the first place we will consider the steaming qualities of a straight boiler compared with that of a

wagon-top. It will be admitted that evaporation is very materially increased or retarded in proportion to the amount of heating surface, and the flues being acknowledged the most effectual part of the heating surface of a locomotive boiler, the essential steaming qualities of the engine must therefore greatly depend on the number of these flues.

The greatest number of two-inch flues that can be got into a forty-seven-inch straight boiler, in vertical rows $\frac{9}{16}$ of an inch apart at the back end, is 142. This will give about eight inches steam room above the flues in the highest place, allowing eight inches of water on the crown sheet. A dry pipe, five inches or more in diameter, must now occupy a place in this space as near the top of the boiler as it can be placed, allowing room for its joint in the front flue sheet. We now have say seven inches from top of boiler to underside of dry pipe. Going back now to the fire-box, we find four inches between top of crown bars and dry pipe, or about sixteen inches from top of crown sheet to top of boiler—ample room to raise the box sufficiently for one additional row of flues; but the box is already so wide that it can not be raised without bringing the ends of the crown bars in contact with the shell of the boiler. Hence we have in this style of boiler the greatest number of flues, the greatest amount of water, and the greatest amount of steam room within its capacity. In other words, we have 142 two-inch flues, eleven feet long, equal to about 809 superficial feet of heating surface; to this must be added about 113 superficial feet of heating surface contained in a fire-box of following dimensions, $35 \times 60 \times 60$, including the Jauriet water arch, making all told 912 feet of heating surface, and fifty-nine cubic feet of steam room, including one dome 25×25 inches. If desired the fire-box may be reduced three inches in width and carried up three inches higher, thus dispensing with one vertical row of flues, five in number, and adding one horizontal row, eight in number, gaining three flues by the operation. At the same time there is yet room for the dry pipe above the crown bars, so that steam may still be taken from the back dome, thereby obviating the necessity of a front one, which, in the opinion of the writer, is superfluous, as he can see no advantage in two domes, unless steam is taken from them both. It will be seen that by raising the fire-box

three inches, it will be necessary to carry that much more water, which will reduce the steam room about nineteen cubic feet, and only increase the heating surface about seventeen superficial feet, clearly showing that what is gained in heating surface is more than lost in steam room by filling the boiler too full of water; so, it appears, that nothing can be gained by raising the box above the height named in the first instance (about sixteen inches below top of boiler).

We will now take the same size of boiler, forty-seven inches in diameter, with ten-inch wagon-top, besides a back dome 25$\times$25 inches, the same as in the case of the straight boiler; will also use same size of dry pipe (five inches diameter), occupying the same place in the front sheet, about seven inches from top of boiler to under side of pipe. If we now increase the height of the fire-box, so as to admit of two additional rows of flues, and make an off-set in the dry pipe so that it will pass over the crown bars as per tracing, we have the following figures: Fire-box four inches higher, or 35$\times$60$\times$64 inches, against 35$\times$60$\times$60 inches in the straight boiler, making an additional heating surface of several feet in the box alone, together with two additional rows of two-inch flues, twenty-two in number, or 164 all told, swelling the heating surface to 1,042 superficial feet, or 130 feet more than we have in the straight boiler. Having raised the fire-box four inches, we must necessarily carry that much more water, which reduces the steam room in the barrel of the boiler to about four inches in the highest places; but by the use of the ten-inch wagon-top, we have fourteen-inch steam room over the fire-box, instead of eight inches, as in the case of the straight boiler. With this showing, we have in the wagon-top boiler fifty-seven and a half cubic feet steam room, including one dome, 25$\times$25 inches, and 1,042 superficial feet of heating surface, against 912 feet of heating surface and fifty-nine cubic feet of steam room in the straight boiler, or a gain in heating surface of about eleven and a half per cent., and a very trifling loss in steam room.

In a twelve-inch wagon-top we would swell the steam room to a little more than that in the straight boiler. It will be observed, then, that we have, by the use of the wagon-top, eleven and a half per cent. more heating surface, nearly seven per cent. more water,

and about the same amount of steam room. The heating surface of t wagon-top boiler may still be increased nearly five per cent. by swelli the sides of the fire-box so as to admit more flues, filling up t front sheet to the circle of the boiler, instead of leaving a usel water space between the flues and the sides of the boiler. T swelling of the box would prevent its being taken out in the usu manner, as it would not pass through the leg or outside shell of t box; but this would be considered no serious objection, as the ba head can always be taken off for that purpose at a little extra e pense, and frequently to a great advantage to the workmen in t adjusting of manipulations for laying out the holes in the new bo There are other advantages in the wagon-top boilers which, thou they may not be generally known, are well understood by compete locomotive runners. Those who have had practical experience wi both boilers, will, I think, testify to the superior merits of the l ter in the matter of carrying water without raising it while the e gine is performing her hardest labor; also to the better working the engine, in consequence of using dryer steam together with th invariably better steaming qualities, and consequently more econo ical use of fuel.

They carry their water better, because they have a larger body hot water in which to neutralize the supply of cold water from t pumps, thereby causing less agitation, or priming. They use dr steam, because the dome from which it is taken is ten inches high hence the steam is less likely to become saturated by the surging the water in the boiler, caused by the galloping movement of t engine. After seven years' experience in running locomotives never run one with a straight boiler in which I could carry m than two gauges of water (or about three to five inches of wa above the crown sheet) while working the engine up to her f capacity, without more or less priming. If at this time the eng should be foul and foaming, it would only be with the greatest c in regulating the supply from the pumps that the engineer would pect to find more than a flutter of water at the lower gauge, a shutting off. Even with a clean boiler, the suction caused by steam passing into the dry pipe, together with the surging of water, will raise a spray which will surcharge the steam to such

extent as to destroy much of its expansive force in the cylinders. In other words, much of the power of the engine will be lost by working water through the cylinders instead of dry steam. It will not be necessary to elaborate upon this subject to convince those familiar with the steam engine that dry steam is the essential prime element of the engine; for steam surcharged with water will carry with it into the very heart of the engine that which will destroy its life, in the shape of a variety of all the impurities contained in the water, such as loose sediment, lime, grit, etc., which will frequently cut the valves, pistons, and cylinders, besides causing the pounding of water between the piston and cylinder heads, rendering frequent repairs necessary to the entire engine. In this connection the writer would state that the use of a perforated dry pipe would, on this as well as many other accounts, be objectionable. While taking steam along the whole length of the pipe might have a tendency to raise the water less, yet it would not wholly destroy this effect, and the pipe being so much nearer the water than a throttle valve in the top of a dome, it would seem to upset the theory that the equalizing of the reception by the perforated pipe would prevent priming any more than a single opening in a pipe twenty inches higher. The perforated pipe would not do at all for a wagon-top boiler, because at high water line the pipe would be half covered with water. In a straight boiler there would be about one inch between the under side of the pipe and high water line; hence, with three gauges of water on an eighty-foot grade, one end of the dry pipe would be under water, consequently both water and steam would be passing into the cylinders at the same time. It has been observed on some roads that dry pipes are more or less coated with scale, showing very clearly that they are, at times, entirely submerged, from the fact that incrustations will not form in the absence of water. The wagon-top possesses superior advantages over a straight boiler of same size, even with same amount of heating surface, because it will carry a larger body of water and at the same time have a greater quantity of stored-up steam from which to supply the cylinders. The theory being as a small boiler is to a large one doing the same amount of work. The small boiler must be constantly crowded to its utmost, while the large one will do its work with perfect ease and with less water and fuel.

There are other considerations in favor of wagon-tops; they being located directly over the drivers, their additional weight, however little it may be, is just where it is needed for traction. It is the opinion of your correspondent that they might be carried up still higher to advantage, at the expense of the cylinder part of the boiler, thereby somewhat reducing the dead weight in front and increasing the weight over the drivers. By reducing the cylinder part of the boiler to forty inches diameter with a fire-box, the same height as the one in the forty-seven-inch wagon-top boiler (sixty-four inches), we would be able to get in the same number of flues that the forty-seven-inch straight boiler now contains and still have eight inches or more space between the upper row of flues and top of the (forty-inch) boiler. If we now carry up the wagon-top twenty-four inches on a radius of twenty-five inches, we will have nearly the same amount of steam room; an equal amount of heating surface, and nearly the same amount of water that we now get in the forty-seven-inch straight boiler, at the same time increasing the weight on the drivers, and reducing the dead weight in front by as much as the difference in the weight of water, size of boiler, smoke arch, etc. Then, by reducing the weight of the truck, saddle, and other things that will admit of it, in the same proportion, we would have a still greater percentage in favor of the wagon-top.

To the questions concerning the strength of a wagon-top, compared with that of a straight boiler, I can only say that we have never heard of a wagon-top blowing off, or even giving way under the pressure, so as to endanger its safety; on the contrary, whenever an explosion of this kind has taken place, the cylinder part of the boiler has, in every instance, given out first. The extra cost of a wagon-top over that of a straight boiler of the same size will not exceed the cost of ordinary domes.

Respectfully, H. A. TOWNE,
General Master Mechanic Hannibal & St. Joseph Railroad.

On motion of Mr. Hayes, Illinois Central Railroad, the report was received.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I think Mr. Towne, in making out his statement, has taken in view, perhaps, the very best construction of the wagon-top boiler and the worst of the straight boiler. His whole re

port seems to be based upon the idea that all are limited or confined to having the cylinder parts of the two boilers of the same size. When I build a straight boiler I aim to build the cylinder part of the boiler larger, and I claim that I have a stronger boiler, with a larger cylinder, straight, than with a smaller cylinder with a wagon-top. For instance, take a forty-seven-inch shell, and by increasing the diameter perhaps one inch, I gain all the heating surface by making room for more flues that he gets from his wagon-top; and I have been looking to increase the heating surface in the fire-box by lengthening it as much as I have by adding to the number of flues. Then, again, as regards steam room, we gain steam room by giving more diameter to our boiler by having a straight boiler, and putting two domes on it. Mr. Towne claims that there is great advantage in having steam room; still, he can not see any advantage in having two domes. We certainly gain considerable steam room by having two domes on a boiler. However, I do not claim much for two domes; but I claim that a straight boiler, with one dome on the center of the cylinder part of the boiler, of a proper size, will carry water to all intents and purposes as well as a wagon-top boiler. But when you place a dome over the fire-box, then it is liable to all the objections that Mr. Towne brings against the boiler for carrying water; but when it is in the center, it then becomes a boiler that will carry water well. I have used that form of boiler very extensively, with one dome placed on the center, and never have found any inconvenience in carrying water, and I have never been able to see much advantage from having an additional dome. We have a number of engines running with two domes, taking steam away from the center; but I consider the back dome more an ornament than anything else, for it certainly does not carry water any better than a dome in the center. The dome should be a large one, and then it takes the place more of a wagon-top. If you reduce the dome in diameter, you will find that you carry water poorly. It is so small that it creates a current which carries the water up with it. In my judgment, the strength of a straight boiler is very much greater than that of a wagon-top. Those boilers you spoke of, Mr. Setchel, were wagon-top boilers, were they not?

Mr. SETCHEL, Little Miami Railroad—Yes sir; but the wagon-tops were not stayed.

Mr. ELLIOTT, Ohio & Mississippi Railroad—That only goes to show that they require so much additional strengthening, while the straight boiler is strong of itself, and requires none of this staying to stay these straight sheets. From your crown bars there is a place that is, perhaps, the most difficult part to strengthen in a boiler; in the straight boiler we have nothing of that kind to contend with.

Mr. TOWNE, Hannibal & St. Joseph Railroad—In regard to the strength of the wagon-top boiler, as compared with the straight one, in theory there may be considerable difference; but, as stated in the report, I never have

had any trouble. I have never heard of a case where the wagon-top has given out before the straight part of the boiler. In cases of explosions the straight part of the boiler has invariably given out first. Mr. Setchel stated a moment ago that those wagon-tops were not stayed which accounts for the fact of their giving way. If a wagon-top boiler is properly stayed it will remain in position just precisely as well as a fire-box will hold together with your stays passing longitudinally. You must stay the box there, or you can not hold it at all. So in the same way, you must stay the wagon-top of a boiler, or any other part of a boiler that is out of the regular circle. Our boilers are thoroughly stayed in the wagon-top, and consequently we have no trouble with them whatever. We have never had them leak at all. In reference to the size of the boiler to which Mr. Elliott has referred, the two kinds of boilers are compared in the report. A forty-seven-inch straight boiler, for instance, is compared in heating surface, steam room, and capacity for holding and carrying water with the same size of wagon-top. We get in a forty-seven-inch wagon-top boiler eleven and a half per cent. more heating surface, about the same amount of steam room, and considerably more water is carried. I do not remember the exact percentage of increase. Consequently we get a great deal better boiler, with the same size of shell. In other words, we get precisely as good a boiler with a forty-seven-inch shell, with a ten-inch wagon-top, that we get in a fifty-inch straight boiler according to the drawings which have been gotten up, showing the capacity of the two boilers. Therefore I claim that if you use the wagon-top boiler you can dispense with the very large cylinder portion which it is necessary to use with a straight boiler alone. We find a great deal of difficulty with our present gauge, and probably shall find more with the narrow gauge which is advocated, in getting the boiler sufficiently large. A forty-eight-inch boiler is as large as we can conveniently get into our present gauge, unless you carry it up high. Fifty-inch boilers are, I believe, the largest that are made. The larger we can get a boiler the better, to be sure, but if we can get the same amount of heating surface in a wagon-top boiler of forty-seven-inch diameter that we can get in a fifty-inch straight boiler, I do not see why a wagon-top boiler is not the better one, because it carries the weight back on the drivers, where we want it. If we could only still further reduce the length of our boilers and put the weight on the drivers, all our engines would do better. Most of our engines are thirty-three ton engines. carrying from ten to thirteen tons on their trucks. By reducing the cylinder part of the boiler, we can reduce that weight very much and carry it back on the drivers, and still maintain the same kind of engine without throwing away any portion of those engines that are now in use. I have here drawings showing the difference between a wagon-top and straight boiler with the same size cylinder. [Mr. T. explained the drawings in considerable detail, showing that the statements he had made in regard to the relative merits of the two classes of boilers were supported by the facts.]

Mr. ELLIOTT, Ohio & Mississippi Railroad—I see the point which Mr. Towne wishes to make on the wagon-top, in comparison with the straight boiler, and to my mind there is just the same point of objection. I claim that there is great advantage in having the dome in the center of the boiler, instead of having it right over the fire-box or crown sheets, as is illustrated by the deposits made on the crown sheets in the boiler. I think that, to a great extent, may be attributed to the fact of taking the steam over the crown sheet, which has a tendency to create a current and draw in the foreign substances floating over the crown sheet, and these are deposited there, where it is a very difficult matter to remove them; whereas, in the other cases the tendency is to draw everything to the center and deposit it on the flues where it is likely to reach the bottom of the boiler, where it can be easily removed. The question, however, is as to the matter of strength and steaming qualities between the wagon-top and straight boiler. I claim that I can go to work and make a straight boiler with all the steaming qualities that the wagon-top has; but it would not be the same boiler that Mr. Towne has drawn. Another point. In my experience nearly every boiler that I have ever seen burst or explode, the rupture has been either on the sheet connecting the cylinder part with the wagon-top, or the wagon-top itself, extending through the cylinder part of the boiler, running perhaps into the front ring. Nearly all the boilers I have ever seen give out, have given out in the neighborhood of the connection between the cylinder and wagon-top. I have seen four out of five give out in that way, and that is the point, I think, we want to determine as between the wagon-top and straight boiler. I have known cases where men who have been building straight boilers have come back to wagon-tops, and about the only reason they conld give for it was that their engineers liked them better; and I believe that a great many master mechanics have gone back and now build wagon-top boilers contrary to their own judgment, because engineers, as a general thing, prefer the looks and like the wagon-top boiler best, without having any good reason for it. If the straight boiler is the best, I claim that we ought to find it out and build that kind of boiler in opposition to any fancy or taste of this kind. I would like to hear the experience of some who have tried the straight boilers.

Mr. JOHANN, late Missouri Pacific Railroad—I would like to ask Mr. Towne whether he has had any of those straight boilers in operation, or whether he is merely illustrating from the drawing his ideas?

Mr. TOWNE, Hannibal & St. Joseph Railroad—We have no straight boilers except for a few switching and construction engines. So far as the "fancy" of engineers is concerned, there is no fancy about it. I have run an engine with a straight boiler long enough to know just how that thing works, I believe.

Mr. JOHANN, late Missouri Pacific Railroad—I would simply state my experience in relation to this. We have had forty-six new engines that were about equally divided between three builders; one lot with straight boilers

and plain fire-box, with a single dome; another lot with wagon-top boil with a plain fire-box, with a single dome; the other lot had wagon-top bo ers, with about eight-inch combustion chambers. The number of flues all the engines was the same, as near as I can remember. We had conside ble trouble with the wagon-top boilers of both classes, from their giving w in the gusset sheet, on the outside of the shell, and we have tried very ma ways to overcome that difficulty. The boilers were made of American ir and we were constantly patching them. The wagon-top boiler with the co bustion chamber not only gives us trouble on the outside of the gus sheet, but inside, in the fire-box, where the distortion takes place for t combustion chamber. Not one of the straight boilers has given us a trouble and in regard to their performance, a straight boiler with a sin dome, and the same number of flues as the wagon-top, performed equa well as the others, making steam just as well, and hauling as many ca That is my actual experience for four years, and I have finally come to the co clusion that the nearer we keep to straight lines, the less trouble we will ha with our boilers, and if I have anything more to say in regard to engir my preference would be for straight boilers, with this exception as rega the dome. Although those have given us no trouble, and have done just well as the wagon-top, yet we have had one or two cases, through the ca lessness of the men, of overheating the crown sheet. I believe that dome should be on the cylinder part of the boiler, as near the center as p sible, so as to get it on the axis of the boiler, so that when you are going or down grade, you will have the least disturbance at that point. Tha the only difference that I would make. With reference to having two don I do not think that it is absolutely necessary, but I would have a small do over the fire-box, for the purpose of putting the safety valves there m easily. I would place my dome and take my steam from about the axi the boiler.

Mr. SETCHEL, Little Miami Railroad—I only want to say one word regard to the suggestion that I was building boilers without staying wagon-tops. The boilers I spoke of were built by the manufacturers the road before I took charge; and, as Mr. Elliott says, the point where th gave way, was along the connection sheet between the cylinder part of the boiler and the wagon-top along the seam.

Mr. HAYDS, Illinois Central Railroad—Before you close the subject, p haps I had better say a word or two. I have written something upon t subject which I would like to have read, before the discussion closes, wh will express my ideas better than I can do it on the floor. We have u both wagon-top and straight boilers, and I am free to admit that the strai boiler was a cheaper boiler to make and the stronger of the two; but ou the western country, where the water is so bad, so impure, and there i much lime deposited, we must have room to get into our boilers and cl

the crown sheets once every four months, or once in six months, certainly and hence it is necessary for us to use wagon-top boilers, with a dome upon the wagon-top, in order to get in. I would like to have our report upon that subject read, which will express my views.

Mr. Hudson, Rogers' Locomotive Works—Speaking with regard to the opinion of engineers or runners of locomotives, I apprehend that many of us have acted in that capacity at some time or other. I have myself, as long ago as 1836, and occasionally for a good many years since, and my own experience with regard to wagon-top boilers and with regard to two domes is, they carry water better, and that there is less danger of their priming. They will stand a sudden opening of the throttle better than the straight boiler. While on this subject, I may say that the location of the throttle and the way you take steam has something to do with the comparative capacity of straight and wagon-top boilers for steam. In the one case, if you take the entire steam capacity of the steam pipe out of the boiler, and locate the throttle in the smoke-box, you have added that much more capacity to the boiler. In the other case, if you take the throttle dome out, you take the top, of course; and practically, I know that with the throttle located in the dome, with a straight boiler, you must be extremely careful how you handle it, otherwise you will take up water. While I agree in the opinion that it is better to locate the dome on the straight boiler somewhere forward, perhaps not exactly in the center of the boiler, but about in the center where the steam comes with an even flow from each part of the boiler to that point, I am in favor of two domes, from the experience I have had, not as a locomotive builder, but as a practical locomotive runner. I say, I prefer two domes to one. Why? If we take steam only from the forward dome, and locate the safety valves and throttle on the back dome, we divide the currents when the engine has a surplus of steam. We all know that lifting the safety valve very much beyond its ordinary height will carry out the water. I have known of cases where pretty much all the water was carried out of the boiler through the safety valve by raising it higher than it ought to have been. Therefore, from that experience, I give my testimony in favor of the superiority of the wagon-top boiler and the two domes. I believe that the straight boiler, as ordinarily constructed, is the safest; but I believe also, at the same time, that the wagon-top can be made equally safe; it is a matter of judgment as to how you will stay them. It is a question of practice as to how they are ordinarily stayed; but as they are ordinarily stayed I have but little doubt that the straight boiler is the strongest. At the same time I have known cases of the sheet over the top of the straight boiler giving way; I have known also of cases of wagon-tops giving way. I do not think that proves anything, except that they gave way in their weakest part.

Mr. Robinson, Great Western Railway—I have heard nothing said here

about European experience, and I would like to state that the opinion is pressed in such conventions as this held in England (the only institution t rejects them is called the "Institution of Mechanical Engineers"); they that in making boilers the plate should either be made circular or straiş By the word "circular" an ellipse is not meant. Now, the wagon-top boiler an ellipse in it. It is circular in shape, and it comes down to a larger rad at the side, until it forms the straight part again. That was the wagon-t it made the barrel circular, and the cylinder required no staying; theref the back part was just as strong as the cylindrical part of the boiler. N withstanding that (mark the fact) fifteen years ago the subject came when nearly all the railroads in Europe were using wagon-top boilers m in that way, and now they have all given it up. I was over in Europe sping, and made special inquiries in regard to this matter, and I don't th you will find ten per cent. of the boilers used in Europe wagon-top boil because they insist upon circular or straight lines. The reason why t have given up the wagon-top in Europe especially, is this: They have tr both. On the line I was on we had about four hundred engines, and t were all this wagon-top kind; they call it the raised fire-box there; but, the present time, they have abandoned it entirely. When I was there t were commencing to build two hundred engines with straight boilers. Th is no prejudice on the part of locomotive runners in favor of the strai boiler; one boiler will run as well as the other, and give as good result the consumption of fuel; and in regard to any prejudice which may e I think if there had been any I should have heard it where I was, as as in other places; but, of course, the great thing they want to arrive a to get the strongest boiler consistent with the results and cost. I think wagon-top has a very bad shape indeed. If you will have it, make it as t do in Europe, circular, and raise the center and describe the whole ci from one radiating point. If you must have a wagon-top boiler, you find that in order to stay the fire-box they stay the boiler; therefore top shell and the fire-box are held rigidly together by stays. That is strongest part of the boiler; the weakest part is from that point to where stays begin on the other side. You never find any stays there. If you steam into a bladder it will press it out into a true circle; that is a nat law. The tendency of this boiler is to throw that out into a circle. takes the nearest point, and, unfortunately with us, that is the weakest p The strongest pressure, therefore, in a locomotive boiler, the point whe is doing the most damage, is at this point, where it is not stayed, becau wants to go out and form a true circle; and in most boilers there are inches that the steam is trying to press out and get into the true circle that is the weakest part, and if the boiler will burst, it will give way th and the reason is, because there are so many angles and crooks that plate gets weaker in this seam than anywhere else. I contend that

straight boiler is far preferable. With regard to the position of the dome, I quite agree with the last speaker, that the position of the dome should be at that point where you can get the largest quantity of steam into it. I have a drawing here which gives my own idea as to what a good boiler should be. This dome is placed about one-third or a little more over the driving wheel, because I want the weight there. I would not have the dome forward of the driving wheel. The right position for the steam is about one-third of the distance from this end, because most of the steam is raised over the fire-box, and the least steam at this end; therefore, in the one-third between the fire-box and the dome, there will be as much steam raised as in the other two-thirds, speaking roughly. We also, you perceive, put gusset-stays at each end. Mr. Towne has mentioned the fact that it is necessary to get into the boiler to make repairs. Having longitudinal stays through the boiler, we find it very difficult to get into the boiler unless we arrange it in this way. This is the English plan; gusset-stays at each end of the boiler, so that a man can get down through this man-hole into the boiler, and there is about eighteen inches through which a man can easily crawl and do any work that is necessary. That has about 1,000 feet of heating surface; it is about 50 inches in diameter, has 148 tubes, and has a very fine space for the circulation of water on the sides. You see, one great advantage of the straight-top boiler is that you increase the diameter of the boiler in order to get the right number of flues in, and you get very fine space on the side.

Mr. Hayes, Illinois Central Railroad--You have said there are gussets at each end. Now, each of these tubes has a stay-bolt; the pressure of these is upon each head of the boiler, and holding it. Now, if you put a gusset-stay here and here, does not that leave a weak point in the boiler here [referring to the drawing] that is liable to pull in two? Remember, you have several tons pressure within those tubes, and several tons there. Does it not leave a weak place there?

Mr. Robinson, Great Western Railway—Does not the same thing apply to the longitudinal bolt?

Mr. Hayes, Illinois Central Railroad—Run them through past the center, then you have no weak point.

Mr. Robinson, Great Western Railway—The longitudinal bolts will be just as rigid as the barrel of the boiler itself.

Mr. Hayes, Illinois Central Railroad—The plan recommended by the Committee was to run the stays from this to that head, past the center; consequently you have no weak point. I have seen a boiler pull right in two by the longitudinal pressure on top of the boiler, because they were no stays there.

Mr. Robinson, Great Western Railway—All I can say is, that I have built boilers like these for about eight years and seen them built, and I have never experienced any trouble in that respect. Of course, it is one

of those points on which, if there is any light to be gained by observation experience, it is very desirable that we should have it.

THE PRESIDENT—When the report on "Boilers and Boiler Material" w up yesterday, there was one question and answer laid over until to-day, wh this report should come up. It will now be read:

"Your Committee recommend the wagon-top, in preference to tl straight boiler, for locomotives, especially where impure water used. It affords greater steam room, larger water surface over tl furnace, and decreases the liability to foam when the water is ba. It is easy of access when the mud and scale must be removed fro the crown sheet, or when repairs are necessary to the numero braces over the furnace, and, as stated by Mr. Wells, of the Jeffe sonville, Madison & Indianapolis Railroad, it distributes the weigl to greater advantage upon an eight-wheeled engine, with four driver than does the straight boiler. The cylinder part can be smaller i diameter, and consequently lighter, than with the straight boile thereby lessening the weight upon the truck; while the furnace en will have greater weight, due to the wagon-top, and will give propo tionately more adhesion to the driving wheels. The straight boil can be built at less cost than the wagon-top, and is subject to fewe unequal strains; but your Committee think the advantages of th latter form more than compensates for the defects. Two domes a preferable to one, on boilers with limited steam space, and on boile using impure water, provided steam is taken from both domes. Le ser variations in water level and dryer steam in the cylinders a obtained.

"Where the water is pure, or the boiler capacity large in propo tion to power of engine, one dome is sufficient.

"Very few speak favorably of the perforated "dry-pipe" for loc motive boilers."

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—It seems t me, from the discussion that we have had here in regard to the different pla of boilers, that the only advantage that can be claimed for the wagon-tc boiler is that of a better distribution of weight on the ordinary pattern of a eight-wheel locomotive. As has been stated in the report of the Committe the object there is that the boiler can be smaller at the front end, that is, tl cylinder part of it, than the straight boiler, the total capacity of the two b

ing the same; therefore the back end of the wagon-top boiler would necessarily be heavier than the back end of the straight boiler, placing the weight where it would be of some advantage. I apprehend that there is no difficulty in the mind of any good mechanic in staying a wagon-top boiler sufficiently, so that it would be practically just as good as the ordinary straight boiler. We all know that boilers frequently give trouble in what is called the connection sheets between the wagon-top and cylinder part of the boiler, and we usually find the trouble on the side of the boiler near the center line; and in passing from a circle with the center in one point, to a circle the center of which is six or eight inches above that, there must necessarily be a flat place in that connection. And as boilers are generally built, we know that that part of the boiler is not sufficiently stayed, and pressure coming upon it has a tendency to throw it out and bring it in the form of a circle, throwing an unusual strain upon the bolts in the top of the fire-box near the flue sheets. For some years I have, in boilers of that kind, always placed one or two bars in that connection sheet; placed them vertically in the boiler immediately ahead of the flue sheets, staying that part of the boiler the same as the crown sheet and fire-box are stayed, running those stays down until they come some six or eight inches below the center of the boiler, and extending them up to eight or ten inches above the center line of the wagon-top, and riveting them to the side sheets the same as the crown bar is riveted to the crown sheet. I have never had a boiler stayed in that way give any trouble whatever. They never leaked at these cross seams, and I apprehend that if boilers were stayed in that way there would never be any trouble with their giving out at that point. Also, immediately over the top row of tubes, from one to the other of those bars, I would place a connecting bar, running across the boiler, connecting two of those bars together, the connection being made by a fork and pin at each end. When boilers are constructed in that way it seems to me they are certainly as safe as any ordinarily constructed straight boiler. This point could be just as easily stayed as the flat sides of a fire-box, if there is a proper disposition made of the braces.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railway—Do you run them between the tubes?

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—No, sir; these bars run vertically; they run down below the fourth row from the top, outside of the flue, between that and the shell. They are riveted between the shell and the tubes. They are not cross stays. There is a cross stay connecting two of those bars above the top row of flues, as close down as we could get them, keeping the sides from spreading out, and at the same time those bars running vertically give that flat side stiffness.

Mr. YOUNG, Cleveland, Columbus, Cincinnati & Indianapolis Railroad—I would like to ask Mr. Wells whether the action of the iron, in expanding and contracting, would not be liable to break at the end of the bar?

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I h never had any difficulty of that kind.

THE PRESIDENT—I will state, before this report is closed, that Mr. P brick, Maine Central Railroad, asked to be excused from serving on Committee, and Mr. Griggs, of the New York & Oswego Midland Railr acted as chairman.

Mr. PHILBRICK, Maine Central Railroad—Several gentlemen wish to h the question put, in the form of a vote, how many would prefer the wag top boiler and how many would prefer the straight boiler; I therefore for a division on this question.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—Before vote is taken I wish to make one statement. My preference for the wa top boiler is simply that there can be a better disposition of the weigh the ordinary pattern of eight-wheel locomotives; but when you come to ten-wheel engine, or any engine where all the weight is carried on the d ing wheels, I prefer the straight top boiler.

The PRESIDENT put the question, How many were in favor of the wa top, on that form of engine having four drivers and truck, and twenty-e gentlemen arose. Thirteen expressed their preference for the stra boiler.

On motion of Mr. Hayes, Illinois Central Railroad, Mr. Coleman Seller Philadelphia, an associate member, was invited to read a paper he had pared for the Association.

ON THE SELF-ACTING SLIDE LATHE.

In compliance with the request to furnish a paper to be read be the American Railway Master Mechanics' Association at its meet in Boston, it has occurred to me to present a few thoughts on theory and construction of that important machine, the self-ac slide lathe.

Prominent in the list of tools for the equipment of the work-s stands the lathe. It was the first machine tool—it is the most im tant. Upon it has been expended much thought and about it been much written. My excuse for treating of it is, that during past few years the lathe has been much improved; its functions l been carefully studied and its form changed to agree with the now ter known theory of its operation. Traditional shapes and dev have been discarded, and new ones are becoming familiar to the who use the lathe.

It must be conceded that the requirements of a good turn

lathe are, that it must turn a true circle; it must turn a true cylinder; and it must, when facing off, produce a true plane surface. The screw-cutting lathe must, in addition to these requirements, produce a sufficiently perfect thread. It is not only necessary that the lathe should fulfill these requirements when new, but it should continue to do so year after year with the least possible need of adjustment or repair.

It has been said that good workmen can do good work with poor tools. Skill and ingenuity may indeed accomplish great results. The problem of the day, however, is not only how to secure more good workmen, but how to enable such workmen as are at our command to do good work, and how to enable the many really skillful mechanics to accomplish more and better work than heretofore. In other words, the attention of engineers is constantly directed to so perfecting machine tools as to utilize unskilled labor.

The turning lathe, being the oldest of all machine tools, has been more hampered by traditional devices and shapes than more recently contrived machines. Changes for the better have to be made, often in opposition to the prejudices of the working men. This opposition has not, however, deterred engineers from steadily improving the machinery they design, as new uses and new requirements seem to demand a change. Much more is required of the turning lathe now than was thought of a few years ago. More and better work must be done by it with less skillful workmen, and it must be adapted to the various kinds of work required of it in particular kinds of manufacturing. Thus many lathes adapted to special purposes have been designed and designated by the names of the classes of work they are intended to accomplish. Through all the various forms of lathes there are certain parts and principles in common, and these parts and principles may be considered without treating of special or unusual forms. Certain general types of parts of lathes have become as well known by name as any other familiar objects, and mechanics can readily understand the characteristics of these peculiarities when brought to their notice by name only.

Thus to speak of a lathe shear as a "V shear," or a "flat-top shear," conveys to those for whom these remarks are intended a sufficiently clear idea of the two principal forms of the lathe-bed or shear now

in use. The V shear has been the favorite in this country for many years; the flat-top shear is the rule, not the exception, in England.

In view of the well known fact that durability of machinery is largely dependent upon extended surface, when surfaces move or slide one on another, it is rather surprising that the flat-top shear should have met with so little favor in this country up to quite a recent period. Theoretically, it presents the largest wearing surface and is the most easily made. The saddle of the slide-rest bearing over its whole under surface, may find a support up to edges of the center opening in the shear. Having less distance to span unsupported than on the V shear, the saddle may be made thinner and yet strong enough, thus increasing the capacity of the lathe-swing over the slide-rest. In lathes, with V guides, there are usually four of these guides; the two outer ones serving to guide the saddle, and the saddle must of necessity span the entire space unsupported from one V to the other, hence must be thicker and heavier than if resting on a plane surface. The nominal capacity of any lathe is what it will swing over the shear; the actual capacity for cylindrical work being what it will swing over the slide-rest—hence the advantage of less thickness in the saddle if of sufficient strength. With less thickness is consequently less weight to be moved—an important consideration in large lathes and worth considering in the smallest. The extended surface prevents rapid wear. The flat surface is no more apt to catch dust than the V's are, and the chips are as readily pushed aside by the saddle. That the shear surface must not be allowed to become gummed up and dirty from neglect, is a merit rather than a disadvantage.

The flat-top shear can be readily planed true on its upper face, on its outer edges, and on its inner edges. The outer edges guide the saddle, lost motion being taken up by shoes or gibbs. The lathe heads are guided by the inner edges. The parallelium of all the edges can be readily insured. Convenience in moving readily, requires the poppet or back head (which in the flat-top shear is guided by the inner edges) should slide easily, and hence should fit loosely. It is of the utmost importance that it shall always hold the same position as to line with the other parts of the lathe when clamped ready for use. This suggests placing a V on the under side of one

of the inner edges; and thus, by means of the clamping shoe, draw the head always up to the same straight edge. I consider this combination of a clamping V, on the under side of shear-top with a flat surface above it, as one of the most important modern improvements in lathes. The idea originated with Mr. William Sellers, of Philadelphia—it is one of many very advantageous changes made by him, and is the result of many years' study of this important tool.

The functions to be performed by the lathe-shear or bed is to maintain the driving head or live-head spindle in line with the poppet-head spindle, and to carry the cutting tool parallel with this center line. It must do this under various conditions of strains. Screwing up the centers to hold the work tends to bend it in one direction; the pressure of the cut tends to bend it in other directions. A clear idea of a number of these strains can be had by conceiving a rigid driving head and a flexible shear submitted to the strain of a heavy cut. The tendency in such a case would be for the driving head to rotate the work to be turned, and, by means of the resistance of cut, rotate the saddle about the work and wind the shear around it also; hence a lathe should be able to resist lateral, vertical, and torsional trains. The longer the bed the more elastic is it in regard to torion, unless well supported by cross girts extending up as nearly as ossible to the top and forming inflexible ties between the I beams hich represent the sides of the shear.

The lead screw in screw-cutting lathes should be placed within e bed, and, when supported over its entire length by resting in a ugh planed out to receive it, is not subject to deflection. Mainning its right line it will produce a truer thread than if unsupported, ept by its nut and end bearings. By being placed under the ar top it is entirely protected from falling chips and dirt.

Upon the perfection of workmanship on the spindle of the live head ends its possibility of turning a true circle: Upon its freedom m end motion, and the exact placement at right angles to it of the of the cross slide-rest, depends the possibility of producing a true ne in facing.

The spindle must be round—truly round—as it will reproduce its n shape on the work being turned. Theoretically, a hardened el spindle running in hardened steel bearings, the spindle and the

bearings being made true after having been hardened, presents tl most reliable conditions of correctness and durability. Fortunatel modern improvements in methods of working hardened steel furni means of perfecting this important part of the turning lathe, but adapt it to the possibility of economical construction some importa changes must be made in form. The traditional collars at each e of the journals must be dispensed with and the front journal be ma truly cylindrical and supported over its entire length by a tr cylindrical bearing. The back bearing may be conical, and o stationary ring or collar of hardened steel secured to the spin back of its back bearing may be ground true, and be made to r between hardened steel plates without any lost motion and no liabil to stick or jam. This form of back thrust does away entirely wi the tail screw, presents a more extended and durable wearing surfa and permits the spindle to be extended through the back support a receive change wheels of any size for screw cutting or feed.

The form of the live-head stock should be such as to hold t front bearing in a rigid manner against lateral strains, and the b bearing against a strain of spindle pressed endways.

The cone speed should be so proportioned to the gearing in b and tripple-geared lathes as to insure an exact ratio of change fr the fastest to the slowest speed, in each and every change; tl with five lifts to the cone in a triple-geared lathe, fifteen spe should be possible, each proportionately slower than the one next t The cone pulley on the spindle should be of iron turned outside inside so as to be perfectly balanced, and its inner cone sleeve sh present an extended surface on the spindle capable of proper lu cation.

The spindle should be made of the best cast-steel, roughed then hardened and reduced to the proper shape after hardening suitable machinery. The conical hole for the moveable center sh be finished true after the spindle is made true on the outside. hole must be as true as the outside else the center can not be pu place so as to be in adjustment. Too much care can not be t in the manufacture of this important part of the machine.

Hardened steel spindles have been made in this manner for l as large as forty-eight-inch swing, the front bearing of such a l

being five inches in diameter; but practical difficulties in the way of working with safety such large masses of hardened steel prevents its adoption for spindles larger than about three inches diameter.

On all double-geared lathes the face plate should be made to unscrew for convenience of changing the size and for the ready application of chucking devices. The overhanging end of spindle to receive the face plate should have a portion of its length next to the shoulder truly cylindrical, without any screw thread. The screw on the end may be made short and should fit loosely in the face plate; but a very careful fit should be made of the face plate on the plain part of the spindle, and the shoulder against which the hub of the face plate abuts should be made very true. This arrangement insures the face plates always running true, no matter how frequently it is changed, or how loosely the screw may fit, provided the fitting parts are not bruised or injured.

I should here remark that spindles made as described have been tested during many years' constant hard usage, and have been found to show no appreciable wear. Possible adjustment of all wearing parts should be provided, but such adjustment should not be at the whim or convenience of the workman using the machine, as is the case with the spindle collared at its journals and provided with a tail screw for the back thrust.

I have already mentioned the method of holding the poppet head so as to insure its alignment by means of the V on the under side of the flat-top shear. Its spindle should be carefully fitted, and a device recently patented by Mr. Pfaut, with A. Whitney & Son, Philadelphia, is of great service in insuring stability. He clamps the spindle at its extreme end of bearing by means of a split conical sleeve forced or drawn in by means of a screw. This takes up all lost motion and insures the alignment of spindle.

If lathes were not required to turn tapers as well as cylinders there can be no doubt that a poppet head made in one piece, resting on the shear over a sufficiently broad surface and capable of adjustment sideways only to the extent of practical alignment, would be the simplest and the best. In our own practice we prefer this system, and adapt to lathes requiring it a device which enables the turning tool to be guided by former bars, and thus to produce conical or

irregular shapes. This device, called technically a former attachment, does better work of this character than when the centers are set over out of line, for reasons too obvious to all mechanics, and gives a greater range to its capacity.

I may be pardoned for mentioning in this relation what I consider the readiest method of bringing the centers in line after the back head has been set over out of line, in adjusting the centers in the first place or in testing the correctness of a new lathe. A bar of round iron, carefully centered, is turned up a short distance on one end. This turned end being placed next the live-head center, a turning tool clamped to the slide-rest is made to just touch the turned part. Taking out the bar, the tool is moved to the poppet-head end of the lathe, and the bar replaced with its turned end next to the poppet-head center, when, if the tool just touch the turned part as before, the lathe may be considered as in adjustment. A vertical adjustment to the point of the turning tool is of the utmost importance for lathes used for turning work of small diameter. The larger the diameter of the work to be turned the less need there is of such adjustment; in other words, the more latitude there may be in the position of the tool point. Lathes with sixteen-inch swing and under should be provided with some means of raising or depressing the point of tool. Larger lathes, where the rests are compounded, may dispense with this. The feed for turning should be independent of the feed for screw cutting, and the changes of speed to the feed for turning should be capable of graduation to suit the nature of the work between the extremes of speed.

When, as often the case in large lathes, an automatic cross-feed is provided it should be stopped or started by the same motion and the same starting gear as puts in operation the longitudinal feed, but the adjustment to set-feed should be made by a separate device. Workmen can accomplish more if they have not too many possible movements to think about, and as in the ordinary movements of this character they are movements of habit. The devices to accomplish any change of feed should not be of a nature either to confine the workman or to render an accident by the use of wrong feed possible. All sliding surfaces of the slide-rest should be so made as to be protected from falling dirt and dust. This is of the

utmost importance, and too often neglected by makers of otherwise good lathes. For lathes of up to thirty-six-inch swing the very convenient single screw-tool post can be used to advantage, but for larger lathes it is not possible to hold the tool in this way alone if the larger are proportionally powerful. Four screws or standing bolts with clamping bars, as on the apron of planers, answer a better purpose and admit of greater range of position.

What I have thus presented in relation to the prominent features of the self-acting slide lathe is in reality the result of many years observation and study of this important tool by some of our best engineers, and noted by me in a somewhat extended familiarity with the tool, both as a workman and a designer. The turning lathe, as all other machines, should not be made up of conventional forms and devices without good argument to recommend their use. It should be capable of analysis, and each and every part should be constructed with a view to the end to be obtained. Workingmen soon appreciate the advantages of such tools when used by them. Railway master mechanics have better opportunities of examining into the merits of machine tools than many others, and are ever the readiest to appreciate improvements. It is with great pleasure I present these observations to them, and hope they may, at least, suggest thought and aid them in their inquiry into the merits of tools so constructed.

Mr. Towne, Hannibal and St. Joseph Railroad, moved that a vote of thanks be tendered to Mr. Sellers for the interesting and valuable paper prepared and read by him, and that it be placed on the minutes. Carried.

THE PRESIDENT—The next business in order will be to hear the report of your Committee on Finance.

REPORT OF COMMITTEE ON FINANCE.

BOSTON, June 12

To the Members of the American Railway Master Mechanics' Associatio

GENTLEMEN—Your Committee upon Finance have exami accounts of the Association as shown upon the books of y retary and Treasurer, and beg leave to report:

Amount received by Treasurer	$1,
Amount paid by Treasurer	1,
Amount in hands of Treasurer as shown in his report	
Amount received by Secretary	
Amount paid by Secretary	
Amount due to Secretary	
Total amount received by Secretary and Treasurer	$1,
Total amount paid by Secretary and Treasurer	1,
Total amount due Secretary and Treasurer	
Total amount due the Association from delinquents on last assessment	$
Total indebtedness of Association	
Total cash assets due Association	
Less outstanding bill for printing, estimated at about	

We would suggest to those members of the Association v been negligent in paying their dues, that it is of the utmost ance that they should do so at once, as the current expens Association must be met and each member should feel the ance of each bearing his own share.

We also recommend that the usual assessment of $10 fr member be made to meet the current expenses of the ensui and a committee be appointed to-day to secure the same.

Respectfully,

H. M. BRITTON,
JAMES SEDGLEY,
MORRIS SELLERS,
JAMES M. BOON, } *Co*

On motion of Mr. Hayes, Illinois Central Railroad, the report was accepted, and a Committee on Assessment ordered.

Mr. HAYES, Illinois Central Railroad—Your Committee have not been able to go through all the communications presented them, but there are four which we recommend that the Secretary read to the Association.

A communication was read from J. H. Coyne, offering to each member o the Association a copy of his Railway Officials' Annual. The offer was accepted.

An invitation was received from the custodian of the Masonic Temple to visit that elegant building and inspect the various apartments. The invitation was accepted and the thanks of the Association returned therefor.

Communications were also received from Henry Morton, of Hoboken, N. J., inviting the members to visit the Stevens' Institute of Technology at that place, and from the Superintendent of the Boston and Maine Railroad, tendering free tickets to such of the members as might desire to visit any of the stations on that road. These courtesies were accepted, and the Secretary directed to return the thanks of the Association to the gentlemen.

The report of the Committee on Subjects for Consideration at the the Next Annual Meeting was then called for and read by the Secretary.

REPORT ON SUBJECTS FOR CONSIDERATION AT NEXT CONVENTION.

BOSTON, June 12, 1872.

To the President and Members of the American Railway Master Mechanics' Association :

GENTLEMEN—Your Committee, appointed to propose subjects for discussion for the ensuing year, suggest the following for your consideration :

1. Locomotive Boiler Construction.

2. The Operation and Management of Locomotive Boilers, including the Purification of Water.

3. The Comparative Value of Anthracite Coal, Bituminous Coal, and Wood for Generating Steam in Locomotives.

4. The Construction, Operation, and Cost of Maintaining Continuous Train-brakes.

5. The Relative Cost of Operating Roads of Gauges of three fee six inches, or less, and those of the Ordinary four feet eight and half inch Gauge.

6. The Construction and Operation of Solid-end Connecting Rod for Locomotives.

7. Resistance of Trains on Straight and Curved Tracks, and o Wide and Narrow-guage Roads, and of Four or Six-wheeled Truck and with Long and Short Wheel-base.

8. The Efficiency of Check or Safety Chains on Engine, Tend and Car Trucks in Lessening the Danger Resulting from Runni off the Track.

9. The Machinery for Removing Snow from the Track.

10. The Machinery and Appliances for Supplying Fuel a Water to Locomotives.

11. The Machinery and Appliances for Removing Wrecks a Erecting Bridges.

Your Committee also recommend for consideration by the As ciation the advantages which would accrue from offering two p miums of dollars each, for the best design and drawi of machinery for accomplishing the two last named operations.

J. M. BOON,
M. N. FORNEY,
P. J. PERRIN,
W. A. ROBINSON,
W. B. SMITH, } *Committee.*

On motion, the report was accepted.

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—There is one more su ject that I move be added to the list. The best Form and Proportion Axles for Cars and Locomotives; also, Whether there is anything to Gained by the use of Combination Axles and Loose Wheels. Carried.

Mr. ROBINSON, Great Western Railway—During the meeting of our Co mittee yesterday we had a very long and warm discussion on the subject a fund belonging to this Association for the trying of experiments, but could make very little headway with it, because we did not know what t general opinion would be in regard to this subject. I might go on and e plain for half an hour the many vexed questions which worry and ann

railroad superintendents and master mechanics every day of their lives; the innumerable patents which are brought to their notice, the merits of which it is very difficult to discover, and also the various improvements which require an actual test before any truthful result can be ascertained, but the cost would be too great for one road to undertake. The gist of the whole thing is this: That it seems a great waste of money and brains that every road should try each of these experiments, starting at the same point and coming to the same result. It seems to me, if some plan could be devised by which the railroads should appropriate a certain sum, in proportion to their capital or mileage, the master mechanics could each year at this Convention put these experiments into the hands of committees, and some good result would follow. The ideas conveyed to our minds were such that we did not feel that we were in a position to make any recommendation; but it is a matter well worthy the consideration of this Convention as a great saving of labor and brain work.

Mr. SETCHEL, Little Miami Railroad—I have been handed the following amendment to Article IV, Section 2: Strike out the word "one" and insert "two" in the last sentence.

Mr. ROBINSON, Great Western Railway—What is the object of making this amendment?

Mr. HAYES, Illinois Central Railroad—The object is to get more talent into our Association than we have at present. In a multitude of counsellors we can always arrive at better conclusions. There are a great many mechanical engineers in the country who would like to become members of our Association, who, perhaps, could do us a great deal of good, and, perhaps, we could do them a great deal of good.

Mr. SETCHEL, Little Miami Railroad—It seems to me, as I read that article, it covers all that it will when this amendment is made: "Also, one mechanical engineer or the representative of each locomotive establishment in America." It seems to me that if the particular man who came from a locomotive establishment last year can not come this they can send a representative.

Mr. HAYES, Illinois Central Railroad—They can send but one; it is proposed that they be allowed to send two.

Mr. SETCHEL, Little Miami Railroad—I can not see the object in having two from one locomotive establishment.

Mr. HAYES, Illinois Central Railroad—It will be better represented. One individual or corporation may employ a dozen master mechanics, and each one of them may become a member of the Association.

Mr. SETCHEL, Little Miami Railroad—That is true, and each one has hi special dudies to attend to; but I can not see that there is any thing peculiar about a locomotive establishment that should make it necessary for more than one man to represent it.

Mr. HAYES, Illinois Central Railroad—The locomotive establishments

have the best talent in the country, and some of them may have as many five or six mechanical engineers. If we can get the talent of two in the pl of one, is it not better?

Mr. ROBINSON, Great Western Railway—A locomotive establishment have the superintendent and general foreman members of this Associati as the rule now reads.

Mr. HAYES, Illinois Central Railroad—Only one. If the locomotive fo man is on the rolls, then the superintendent can not be. The foreman of road can come in if he is recommended by his superior officers.

Mr. ROBINSON, Great Western Railway—That gives two from a shop.

Mr. HAYES, Illinois Central Railroad—As many as may be in the shop

Mr. SETCHEL, Little Miami Railroad—As Mr. Hayes represents it, it not to secure one representative from an establishment, but two.

Mr. HAYES, Illinois Central Railroad—If they wish to join.

Mr. SETCHEL, Little Miami Railroad—The section provides already fo representative; if one can not come they can send another. I should lik know if they have not the right to send representatives.

THE PRESIDENT—If the representative sent first signs our Constitution has the right to come, if he can not come he can not send anybody else.

Mr. HAYES, Illinois Central Railroad—Dr. Williams, as I understand is on our rolls as the member from the Baldwin Locomotive Works. Williams is a member of this Association, and no other man, as I underst it, from the Baldwin Locomotive Works, can be a member. One object bringing the amendment forward was that Mr. Baird, an old locomot builder, whom I have known from a boy up, might become a member. would be an ornament to the Association.

The amendment was adopted unanimously.

REPORT ON PURIFYING WATER FOR BOILERS

To the American Railway Master Mechanics' Association:

GENTLEMEN—At the last annual meeting, pending the discuss of the report of the Committee on Boiler Incrustation, Mr. Ha said: "To bring this thing to a point, I offer the following re lution:

"*Resolved*, That the Secretary be authorized to correspond w superintendents and master mechanics of railroads, where water impure quality is largely used, with a view to experiment upon process recommended by Mr. Hayes, or some others, for purify water; the result to be reported by Secretary at next annual meeti

"On motion, this resolution was unanimously adopted."

In the opinion of your Secretary it would have been entirely proper to have referred this to the Committee on Boiler Incrustation, inasmuch as it grew out of their report, and this subject had already been taken up by the Committee and discussed at some length; but being greatly troubled with the results of impure water, and not wishing to appear negligent in duty, the Secretary had three hundred of the following circulars sent to the different master mechanics of the country:

"DEAR SIR—At the last annual meeting of the American Railway Master Mechanics' Association, the report of the Committee on Boiler Incrustation demonstrated very clearly that by far the largest repairs on locomotive boilers were caused by the use of impure water. In some sections of the country the water is impregnated with lime and other minerals that attack the iron along the seams, around rivet and bolt-holes, and wherever the grain of the iron has been disturbed in process of manufacture, frequently making it necessary to renew certain portions of the boiler in two or three years, and flues in a year or eighteen months; while in localities where the water is pure or free from these injurious properties, we have reports of boilers lasting in good condition from twenty to thirty-eight years. This being the result of using pure water, it is easy to see what a vast amount of money, to say nothing of the loss of the use of machinery, would be saved to railroad companies if all could procure good water.

"With this view, the Secretary was instructed to correspond with superintendents and master mechanics in regard to purifying the water before it is allowed to enter the boiler, and report at the next annual meeting of the Association. And in order to make this as full and practical as possible, he respectfully asks the benefit of your experience and opinion:

"1st. Is it, in your opinion, practicable to so use the exhaust and waste steam at water stations where steam power is used for pumping, to heat the water to such an extent as to precipitate the lime and other impurities that are injurious to boilers, so as to render it practically pure?

"2d. If such a result could be obtained, would not the expense

saved in fuel and repairs of boilers justify the adoption of such practice, even at an increased expense of pumping power?

"3d. Have you had any experience in heating the feed-water boilers for the purpose above named? and if so, with what result?

"4th. Can you suggest any device for heating the water at wa stations that would not be expensive, and, at the same time, acco plish the desired object?"

Out of twenty-six answers returned, thirteen do not believe practicable; eight assign as a reason the impossibility of heating large a quantity of water as would be necessary at important static where steam power would be likely to be used for pumping wat five that it can not be accomplished to any extent in any quant short of distilling or evaporating. Among these may be number Mr. Van Vetchen, of the Atlantic & Great Western Railroad, reports:

"We have experimented somewhat in this matter. In a tank, sixte feet high by thirteen feet in diameter, a two-inch worm pipe placed to the full depth of the tub and live steam used to heat water, but we were unable with a consumption of three thousa pounds of coal every twenty-four hours to heat the quantity of w ter used during that time—about twenty-six thousand gallons enough to make any perceptible difference in the appearance of boi or flues of an engine which used this water exclusively, and of the that used it once a day or not at all. The kind of boiler used making the steam was of the locomotive pattern, with iron flues thr inches in diameter and eight feet long. The fuel used was soft coa

Mr. Van Vetchen does not state the degree of heat obtained in t water in this experiment, which would be very important in decidi the question as to whether anything short of distillation will acco plish the much desired object.

Mr. Skidmore, of the Louisville Short Line Railroad, repo heating the water used in stationary engine at shops to an average one hundred and sixty-eight degrees, but receiving no special ben therefrom except the saving in the daily consumption of fuel. T scale forming on the flues and inside of boiler from one-sixteenth

one-tenth inch thick in a few months. This statement coincides with the experience of your Secretary, who has for a number of years used a heater for the purpose of heating the feed-water of stationary engines at the Company's shops, and obtained an average temperature in feed-water of one hundred and seventy degrees, but without diminishing the accumulation of scale to any perceptible degree.

H. G. Brooks, President of Brooks' Locomotive Works, a man of large experience in all the departments of railroads, writes: "In my opinion it is impracticable to employ exhaust or waste steam for the purpose you suggest, for the reason that you will by no means succeed in precipitating the impurities of the water to any practical or valuable extent, except by entirely evaporizing and afterwards condensing it. Any less thorough method than this, if heat alone is to be the agent employed, will fail to give satisfactory results. I do, however, believe that if pure water can be obtained it will result not only in greater economy but greater security. My advice to the Association would be to secure the service of a chemist, the most skillful and competent the country affords, and by repeated and carefully instituted experiments determine the most economical chemical agent or agents necessary and competent to neutralize or precipitate the impurities of the water and the expense attending the process on a large scale, then the question of economy will be a very simple problem to solve."

Mr. Griggs, of the New York & Oswego Midland Railroad reports "I do not think the impurities can be taken out of water except by condensation."

Mr. Ham, late of New York Central Railroad, reports: "I think it is advisable to use any means that will enable us to procure pure, soft water for boilers, but I do not consider it practicable to get the impurities out of water by heating it at stations. I would advise the buildiug of earth reservoirs and the using of surface water instead. We have a number in use on this road, and they are giving good results."

Of the thirteen who believe it practicable to precipitate the impurities in water at stations by means of heating, the majority

answer they have had no experience except in heating the water f
use in stationary engines, and for this purpose the result seems to l
generally satisfactory, although two cases are reported where
especial benefit was derived from the heater and it was abandon
as impracticable.

Mr. Hayes, of the Illinois Central Railroad, reports that he is st
obtaining good results from the plan proposed by him at the la
annual meeting, but has had no opportunity of enlarging his vie
by any other experiment.

Mr. Towne, of the Hannibal & St. Joseph Railroad reports: '
doubt whether the exhaust and waste steam of a pumping eng
would heat the water sufficiently to precipitate all its impurities,
pecially at stations where large quantities of water is used. At sı
stations, however, live steam might be employed to make up
deficiency at a moderate cost. I shall endeavor to show in the n
Annual Report on Incrustation the actual saving in repairs and f
by the use of pure water; also, the extra cost of purifying water
the above process before it is taken into the boiler."

This will be of vital importance to the Association in securing
attention of those higher in authority to this subject. Master mech
ics have had the conviction forced home that impure water is the b
of good boilers, but superintendents and presidents do not so read
see or appreciate its importance. Said a master mechanic, in writ
to the Secretary on this subject: "You will find it very difficult
convince, by argument, our railroad managers that by making a su
cient outlay to obtain pure water for boilers it will prove a source
revenue in years to come. You will be met with the reply that th
are visionary theories; but if you can suggest a plan whereby tl
can turn a penny in thirty days you will secure a patient hearin

In conclusion, the Secretary desires to tender his thanks to
President of the Association, Mr. Britton, of the White Water V
ley Railroad; Mr. Chapman, of the Cleveland & Pittsburgh Railro
Mr. Robinson, of the Great Western Railway of Canada;
Thompson, of the Eastern Railroad, of Massachusetts; Mr. Coolid
of the Fitchburg Railroad; Mr. White, of the Evansville & Cr
fordsville Railroad, and a number of others, for the full replies

to circulars, and which have not been mentioned in this report. It has been the aim in making up this report to give the opinions and experience of those who had practically tested the matter under consideration, leaving it for the Association to draw its own conclusions.

All of which is respectfully submitted.

J. H. SETCHEL, *Secretary.*

On motion of Mr. Hayes, Illinois Central Railroad, the report was received.

Mr. HUDSON, Rogers' Locomotive Works—The subject of avoiding incrustations is a very important one, as regards not only economy of fuel but wear and tear of boilers. No statement is required from me on that subject; we all know it; but the important point is, how we shall accomplish it. I gather from that report that it is thought that if we succeed in obtaining pure water we shall accomplish all that we desire. I apprehend that that is a mistake; that while pure water will prevent any deposit of sedimentary matter it will increase the chemical action and hasten the destruction of the material of the boiler to a very great extent. Indeed, I may state, that our steamships crossing the Atlantic have found the substitution of entirely pure water for impure water in their boilers an impracticable thing. In other words, the destruction of the boilers with pure water was so great that they were compelled to introduce a portion of impure water to prevent the chemical action of the water and the destruction of the boiler plates. What we want, in my estimation, is to have an analysis made of the water, and understand what the impurities are, and discover something which will keep those elements in solution, so that we can get rid of them, either by blowing off at the surface of the water or at the bottom of the fire-box; but I apprehend that a great deal of the sedimentary or other matter may be got rid of by a proper use of the surface blow-off. We all know that where impure water is used these sedimentary matters come up from the bottom during the action of the boiler, and if we had some ready means of collecting them and blowing them off, so as to keep them from depositing and attaching themselves to the plates, we should accomplish all we are after. While it is desirable to prevent the deposit of sedimentary matter, I must say I have no faith in doing it by obtaining absolutely pure water. I think we make a mistake when we set that down as a point that is desirable to be gained.

Mr. SETCHEL, Little Miami Railroad—The papers on incrustations are so closely connected with this subject, that I would suggest that they be read before the discussion proceeds.

Mr. TOWNE, Hannibal & St. Joseph Railroad—I would suggest that the Report on Incrustations be postponed until to-morrow morning if there is any other business that can be done to-day. We have now only one hour;

it will take nearly that time to read the report, and it will be forgotten i the morning, and have to be read again.

This suggestion was agreed to, and the report postponed.

The President announced as the Committee on Assessment, Messrs. H. Towne, Hannibal & St. Joseph Railroad; H. Fry, Grand Trunk Railwa and B. H. Kidder, Lake Shore & Michigan Southern Railway.

Mr. Hayes, Illinois Central Railroad, proposed the names of F. B. Miles, Philadelphia, and Professor R. H. Thurston, of the Stevens' Institute Technology as associate members. Recommended by W. A. Robinson, Wells, and S. J. Hayes.

The proposition was referred to a committee consisting of Messrs. Phi brick, Maine Central Railroad; D. Clark, Lehigh Valley Railroad, and L. White, Evansville & Crawfordsville Railroad.

Mr. Sellers, of Pittsburgh—Mr. Stevens, the founder of the Steven Institute, was a mechanical engineer of a great deal of merit and abilit and it was his wish all his life, at some time or other, to found an institutio which should teach purely mechanical engineering. That institution no stands as the only one in the United States devoting itself exclusively to th teaching of mechanical engineering, and with President Morton at the hea of the institution, and with Professor Thurston as Professor of Mechanics, think it is likely to become a great success. I am satisfied that mechanic engineers can at any time make it available to their own use, by appl ing to these gentlemen, and having experiments tried within the walls this institution by the professors, who will do it gladly, upon any questio which it may be important for them to determine. The number of instr ments and the means they have for determining questions of great scientif interest, enable them to do it probably better than any other institution i the country.

The President—We will now hear the report of the Committee on

LAP AND LEAD OF SLIDE VALVES.

To the American Railway Master Mechanics' Association:

Gentlemen—Your Committee on Lap and Lead of Slide Valv and General Principles of Valve Motion, would respectfully subm the following: Your Committee have received replies to the follo ing questions from thirty-three roads:

With locomotives running fast passenger trains.

With locomotives running passenger accommodation trains.

With locomotives running heavy freight trains.

What amount of outside and inside lap, what amount of travel valve, what amount of lead in full and half gear, do you use?

Upon comparing the replies with the report of the Committee of 1870 we find that no additional information on the subject has been received, consequently we deem it unnecessary to duplicate that report.

In regard to balance valves and valves working on rollers, the Committee have received reports from nine roads which have used rollers. Six have taken them out, and the other three give no result of their performance. Eight roads have reported using balance valves of different makes, with good results. One of these valves is reported as saving sixty per cent. in wear of valve gear on one road. A valve of the same make was tested on another road with apparent good results; but, on making the balance inoperative, the engine worked as well as when the balance was supposed to be effective.

It is impossible for your Committee to go into a detailed report of a subject which involves so many questions of expansion of steam, economy of fuel, grades, rate of speed, weight of trains, etc., therefore they would respectfully ask to be relieved of its further consideration.

DAVID CLARK,
H. D. GARRETT, } *Committee.*

On motion of Mr. Elliott, Ohio & Mississippi Railroad, the report was received.

Mr. FRY, Grand Trunk Railway—I have had some little experience with balance valves for the last two years, and it seems to me a matter of very great importance. It is a matter which has not been experimented upon very largely, but is coming into favor with master mechanics, and I think it would be very valuable to the general railway practice of the country to have, from year to year, the various master mechanics, who are trying balance valves, report in our journal their experiments with the valves they are trying, so that we should, from year to year, ascertain what valves are failing and what succeeding. I think we might do this without favoring any particular manufacturer. I think we could trust each other sufficiently to know that they would report favorably upon nothing that was not really good. The success we have met with on the road I represent has been thus far so good that I think it would be found to be a very important matter by those who should try it. I think it is a matter well worthy still further experiments, and I would suggest that the results of any experiments be sent to the Secretary to be published in our next report.

Mr. LAUDER, Northern Railroad—I fully agree with my friend, Mr. Fry, in regard to this subject. I look upon this matter of balance-slide valves as being of great importance, more especially on roads burning coal. I think,

in order to carry out Mr. Fry's suggestion in a proper way, it would be be ter to have a committee appointed for this purpose. I noticed in the rep of the Committee that there was no recommendation made for a committ on valves. I think, as the valve is a very important part of the locomoti in fact the life of the locomotive, that it will be necessary and eminent proper to have a committee appointed on valves and valve motion and t whole subject. I have had some experience with balance valves. I fail to get a circular from the Committee the past year. I was sorry for it, as wished to give them my experience. I have at the present time ten balan valves running, and with great success. I have run one of them for fo years last February, and have not been obliged to face the seats or the valv or do anything to it, up to the present time. I think that a valve which wi do that should be brought into notice by the Committee. I move that a com mittee be appointed on the same subject, to report next year. Carried.

Mr. HAYES, Illinois Central Railroad—I have a model here which has be presented by a gentleman—"A. C. Amona's Double-acting Slide-valve" from the Evansville & Crawfordsville Railroad. It is a new idea to n Mr. Hudson says, however, that he used it twenty years ago. It is said have worked on that road with very good results.

Mr. FORNEY, Railroad Gazette—I should like to call attention to the fa that a great many of the reports which have been submitted have drawin accompanying them, to which reference is often made. It seems to me th it would be a good plan to have the drawings engraved and printed wi the report. They would not be very expensive. I suppose our Treasu would be able to tell us whether there is money enough that could be appı priated for that purpose.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad.—I wou like to ask Mr. Forney if he knows about what it would cost to engrave su drawings as ought to go in. He is somewhat posted in the matter, and p haps can give a better idea than any one else here.

Mr. FORNEY, Railroad Gazette—I have not examined them with referen to making an estimate, but I should think they could be engraved so as accomplish the purpose aimed at for about $250. It is a rough estimate.

THE PRESIDENT—The next report in order is that of the Committee the question: "Is there any Material or Device for Packing Stuffing Bo more Economical than Hemp?"

REPORT OF COMMITTEE ON PACKING FOR STUI ING BOXES.

To the American Railway Master Mechanics' Association:

Your Committee on Packing for Stuffing Boxes present the lowing as their report:

They have replies from over thirty roads, the great majorit

which prefer hemp. Some prefer hemp and soapstone, a few soapstone for pistons and valve rods, and but two think that metallic packing is cheapest.

First, in regard to hemp, it takes a high degree of heat to char it enough to harden it, more than can by any possibility ever be done by steam. Steam at a pressure of one hundred and fifty pounds per square inch has only a temperature of three hundred and forty-three degrees, while hemp will stand easily five hundred degrees. With worn rods, and stuffing boxes screwed up tight at worn place, friction sufficient to heat hemp to charring point might be created. This disadvantage attaches to all kinds of packing, and is due to want of skill and judgment on part of engineer. Hemp has the advantage of always being ready and requiring no special tools to prepare it for use nor any particular size of stuffing box, and can be used as well by the unskillful as the skilled man.

Soapstone of various kinds gives good results, and has its advocates, who say that its first cost over hemp is counterbalanced by its longer use and less friction, consequently wearing the valve rod less.

Metallic packing has been tried by nearly all from whom your Committee received replies, and its use abandoned by nearly all, the result not bearing out its first cost and repairs needed. A great variety of patterns are mentioned, some depending on skill and judgment of engineer, others self-acting by springs or pressure of steam admitted outside of rings and closing them on rods. Wear of rod and consequent leaking of steam seems to be the principal objection.

An earnest endeavor to lighten the labor of engineers, as well as to economize, impels the trial of these various kinds of packing. It is not to be expected that results will be the same on every road. Sandy roads can not give the same as those that are not sandy, nor unballasted as ballasted, nor can engines on heavy, slow freights the same as those on fast passenger. When men of little skill or experience can not get the same work from an engine as those of superior skill and more experience, is it to be expected that results from use of packing requiring such delicate adjustment as some of it does will be the same? Improvements have to be introduced slowly and carefully and men accustomed to their use before they can be expected

to be successful; one failure ought not to condemn it especially whe circumstances are against it. These remarks are merely incidenta and brought out by the fact that such a diversity of results fro trials under similar circumstances are brought to the notice of you Committee by the replies received.

Your Committee would recommend the continuation of the subjec another year.

L. H. SELLARS,
F. A. BISSETT,
J. U. EASTMAN,
} *Committee.*

On motion, the report was accepted.

Mr. HAYES, Illinois Central Railroad—Mr. President, I propose the nam of Henry Morton, of the Steven's Institute, as an associate member of thi Association. Application recommended by S. J. Hayes, Illinois Centra Railroad; A. H. DeClercq, Toledo, Peoria & Warsaw Railroad, and W. A Robinson, Great Western Railway of Canada. Referred to Committee o Applications to become Associate Members, previously appointed.

The report of the Committee on a Uniform System of Computing Mileag of Engines doing Switching Service being next in order, was taken up an read by the Secretary.

REPORT ON COMPUTING MILEAGE OF ENGINES DOING SWITCHING SERVICE.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee on Uniform System of Computin Mileage for Engines Doing Switching Service, appointed at your las meeting, beg leave to report that, in answer to the circular issued b them, they have received replies from thirty-two superintendents o motive power and master mechanics, representing nearly all the prin cipal lines of railway in the United States and one in Canada, an from them we find that three of these lines compute mileage for en gines doing switching service exclusively at the rate of ten miles pe hour for the time that the engines are in actual service; three eight miles per hour; three from six to seven miles per hour; fou teen at five miles per hour, and the remainder at less than five mil per hour; while for engines running local freight trains, where mo or less switching is done at stations along the line, *one of the leadi*

lines of the country allow twenty-four per cent. in addition to the train mileage, or length of division, to engines running their local freight; one line eleven per cent. addition; five ten per cent.; one nine per cent.; two seven per cent.; sixteen from six to two and a half per cent., and five make no allowance at all for switching to engines running local freight.

Your Committee believe that it is a matter of greater importance that there should be uniformity in the computation of mileage for switching than whether the rate per hour or the per cent. allowed is precisely the mileage made or not, so that all roads compute alike.

Where there is so wide a difference in the computation as between twenty-four per cent. of the total mileage of engines running local freights on one line, and two and half per cent. to that of those doing the same kind of service on another line, no correct estimate as to the relative cost of repairs and of fuel consumed, taking the mileage as a basis of calculation, can be made. The same is true with engines engaged in switching exclusively; one line allowing eight miles per hour for every hour that the engine is on duty, while another line, where the service is the same, allows only five miles per hour. In order that the monthly sheet, published by the different roads, giving the cost of repairs and of fuel and other expenses per mile run may be of value in making comparisons, it is absolutely necessary that all roads should compute mileage alike.

The same difficulty is experienced in other matters; as, for instance, where the cost per mile for repairs is given. One line may have had two, three, or more old engines that were worn out, condemned, and consigned to the scrap heap, or sold during the year, while a new engine was built or bought to take the place of each of the old engines so disposed of, the entire cost of such new engines being charged to *new machinery*, while the same thing taking place on another line, the cost of such engines, or proper proportion of it at least, is charged to *repairs* of engines, as it should be, and on this account the cost *per mile* for repairs on these two roads will materially differ, when in reality there should be no difference. The difference, if any, between the value of the new engines that take the place of the old, and the value of such old engines *when they were new* only should be charged to the account of *new machinery*,

the balance is simply making good the old engines worn out—keeping up the stock.

We find also that on some roads an account headed "Stores" is kept separate and apart from that charged to repairs of engines, and that the account in many cases equals one cent per mile run, while on other roads no such account as "stores" is kept; but the supplies charged as "stores" on the one are charged to repairs of engines on the other. Now, for the sake of uniformity and simplicity in keeping accounts, we recommend that no such account as "stores" should be kept, but that all supplies heretofore charged in this account be charged to "repairs of engines," and that to the "oil, waste, and tallow" account, the oil used on the engine and tender, in cylinders, and head-lamp, and the waste used in packing the boxes, be charged, and that nothing else be charged to that account.

This part of the subject may, perhaps, be foreign to the matter intrusted to your Committee for investigation, yet it seems so intimately connected with it that we desire to call the attention of presidents, superintendents, and master mechanics of the different railways to the matter, and urge upon them the necessity of taking such steps as will insure *uniformity* in the charges to "repairs of engines" as well as in the computation of mileage.

If this is not done the monthly or annual reports, as published, will be of no value to any one not familiar with the matter of computing mileage and of keeping the repair account on each particular line as a means of comparison, and might as well be abandoned so far as other lines are concerned.

From the replies elicited to the inquiries of your Committee and from our own observation and experience in the cost of keeping up the repairs of engines engaged in switching service exclusively, we would recommend that for this service six miles per hour for the time that such engines are in actual use be allowed; that for engines running local freight trains an allowance of six per cent. to the train mileage be allowed for switching; that where engines run empty to exceed one-half mile, between where the trains are taken or left and the round house, such mileage should be computed, and that for engines running through freight or passenger trains no computation of mileage should be made for switching.

We make these recommendations trusting that the Convention will fully consider them, and, if approved, that each master mechanic will be governed by them in his computation of mileage, and that in the matter of repairs, where new engines are built or bought to take the place of old ones, the cost of such new engines be charged to repairs; or, where that can not be done, that a statement to that effect be made in the report, so that others may be able to understand such report and to make an intelligent comparison with those of other roads.

Unless there is an entire uniformity in the manner of keeping the accounts, the same things charged as repairs, and the same as new machinery, and the same computation of mileage upon all roads alike, the monthly or annual reports, giving *cost per mile*, will be unreliable, calculated to mislead those not familiar with the manner of keeping the accounts on each particular road, and be of no value as a means of making correct comparisons between the cost of motive power on the different roads, and their publication for that purpose might as well be dispensed with.

All of which is respectfully submitted,

R. WELLS, *J. M. & I. R. R.*,
E. D. PALMER, *P. C. & St. L. R. R.* } *Committee.*
J. H. SETCHEL, *L. M. R. R.*,

Mr. HAYES, Illinois Central Railroad—I move that the report be received.

Mr. SETCHEL, Little Miami Railroad—I would like to amend by adding, and their recommendation adopted.

Mr. GORMAN, Toledo, Wabash & Western Railway—Before that recommendation is adopted I would like to hear some discussion. There are various opinions in regard to the proper allowance for switching, and I would like to hear some of the master mechanics express themselves.

Mr. HAYES, Illinois Central Railroad—It seems to me that if Mr. Setchel will withdraw his amendment, and let the report be accepted and placed on file, that will be the better way, for it will then come up for discussion to-morrow morning and we can adopt anything we choose afterwards.

Mr. SETCHEL, Little Miami Railroad—I have no objection to that, and that was my idea in moving to adopt the report of the Committee. I want to hear the matter discussed, for I am satisfied that one cause of the great difference in the showing made by the monthly performance sheets is on account of the extra mileage allowed to engines.

Mr. WELLS—Jeffersonville, Madison & Indianapolis Railroad—As one of the Committee I will simply say that we made this recommendation in order to bring the matter before the members of the Association, and let it be fully discussed and such alterations and amendments made as the Convention might think proper. When that has all been done, and the discussion ended, then the question can be brought up whether we can adopt that recommendation or not.

Mr. SETCHEL, Little Miami Railroad—I withdraw the amendment with that understanding.

The motion of Mr. Hayes was then adopted, and the Association adjourned to Thursday, June 13th.

THIRD DAY.

The Association was called to order by the President at 9:30 A. M.

Discussion on the Report of Mileage of Engines Doing Switching Service being in order:

On motion of Mr. Hayes, Illinois Central Railroad, that portion of the report recommending a uniform system of mileage was read by the Secretary.

Mr. MAYNES, Selma, Rome & Dalton Railroad—An engine may be in use fourteen hours, but may not do more than ten hours work. It may stand still part of the time. Do the Committee propose to compute it for fourteen hours or for ten? It is necessary that there should be steam up all the time, and there is some expense about it.

THE SECRETARY—It was the intention of the Committee to allow six miles per hour for the time the engine was on duty in the yard.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—In reply to the question the gentleman just asked the Committee, I can state, as one, that I did not propose to recommend that engines should be allowed mileage during the noon hour, or at any other hour or time, when the engine is standing still for some considerable time. For instance, if you compute the time from the time the engine is taken out of the house in the morning until it is returned again in the evening, if an engine is not used during the dinner hour or any other hour during the day, that hour should not be counted in; only just such time as the engines are in service.

Mr. MAYNES, Selma, Rome & Dalton Railroad—I asked this question for this reason, when switching they are in the yard at home; the noon hour, of course, is generally not used, but its equivalent is given at some portion of the time. Men require an hour for dinner. Then there are the hours in the day in which they may stand for two hours, waiting, perhaps, on account of the de

lay of trains, and the cars can not be got to complete another train preparatory to going out, whether we should take that into account and make that deduction on the mileage? It would be very difficult to trace that matter up. You would have to rely entirely upon the statement of the men, unless you adopt some system whereby we could compute and make a fair mileage from the time they go out of the round house in the morning until they come back, and not have to rely upon any statement at all. We know when they go out and when they get back at the shop.

Mr. KEELER, Flint & Pere Marquette Railroad—I don't see any objection to adopting the six miles per hour from the time they go out, with the exception of the noon hour. For the two hours they may have to wait for a late train, if they have to wait, they have got to work as much as if the train was on time.

Mr. YOUNG, Cleveland, Columbus, Cincinnati & Indianapolis Railroad—It seems to me to be very unjust to allow a certain number of miles per hour for switching engines. It would be for us. Some are working the whole time, while others in other yards stand still part of the time. I don't see any other way to get at this thing but to regulate the mileage for each engine. That would seem to be the only just way in my opinion. There is a great difference in the different yards. Where they work in some they are busy all the time without resting the noon hour, while others are laying still perhaps one-third of the time. If they are allowed six, five, or seven miles an hour, some get more mileage than they are entitled to and others do not get as much. I should think it would be better to regulate this matter according to the business of the engine.

Mr. TOWNE, Hannibal & St. Joseph Railroad—I can not see any need of counting the noon hour at all in using the switching engines. In the first place a switching engine is not used unless she is required. Wherever an engine is required, her service is worth her hire, and I see no way to get at that except to allow a certain number of miles per hour for each switching engine in the yard. In a yard where there is a great deal to do it may work more than that, where there is more to do will make up for when there is less. I should think six miles would be about the fair thing. In many yards it would not be more than fair to allow ten miles an hour. Our engines goes out between six and seven; sometimes get in at seven in the evening, and again not until ten. We allow only twelve hours a day. Sometimes she works fourteen hours or as long as fifteen; at other times not more than nine or ten. That makes an average day's work—twelve hours—at six miles an hour, unless on extra occasions when she does extra work. Then we allow extra time.

Mr. SETCHEL, Little Miami Railroad—I can not see any propriety in deducting the noon hour or any other hour, for switching engines while standing still. We allow a certain rate of miles per hour, supposing that that is

somewhere near in proportion to the fuel and stores and repairs of the engi
The repairs, of course, are not going on when the engine is standing sti
that is, the cost, bnt the stores are being used. A switching engine that
standing still every few minutes will use a great deal more oil than an engi
that starts and runs a certain number of miles. You pay the engineer a
fireman when they are laying still as well as when they are running, and
seems to me, in order to arrive at a fair comparison between roads, that it
necessary to observe some uniform system. Now, with us, we allow five mi
per hour and twelve hours for a day's work, which is sixty miles. The en
neer and fireman work twelve hours for a day's work; but in running locom
tives on local freights we allow nothing extra, and never have. Engin
running from the engine house to the train are allowed the mileage th
make, and not a mile over. I am satisfied that a great part of the differen
between performance sheets that we exchange is owing to an excess of miles
allowed. Perhaps it has been the custom for years. Some years ago I w
on the Louisville & Nashville road, and we invariably allowed there t
miles an hour for switching engines. When you come to take six or eig
switching engines, and put the cost per mile run for fuel, repairs, etc., and d
vide it up into seventy-five or one hundred engines it makes a material d
ference in your performance sheets; but how are we going to tell this? C
superintendents watch us and compare with other roads, and it is right a
just that they should. So far as I myself am concerned I confess to have
laudable ambition to do as well as any man in the country can do under t
same circumstances, and when my superintendent comes to me and says
are not running as cheap for repairs or oil, I want to know whether they
the miles or not, or whether it is based upon an extra number of miles.
has been the custom of some roads to allow—as one of the leading lines
stated in the report—twenty-four per cent. for mileage on engines runn
local freight. Take that on two thousand or two thousand five hundred m
and it makes a material difference in the showing of the performance sh
and it is just to each member here that we should adopt a uniform syst
I don't say we can say to our superintendents, "We are going to do th
because that can not always be done. Some roads have kept their reports
years, and they desire to refer back and see whether the late repairs com
with previous years, and in such cases the superintendent might object to
difference being made in the rate of mileage or to any difference being m
in the cost of repairs That is something we can not say that we will
but we can say this, that when these variations are made from what
Convention may determine they will abide by in making out their rep
we will make a note of it on our report, so that we will all understand it
be able to make an intelligent comparison. I see a great number of r
that include in the matter of repairs as extra expenses the putting on
tire, or the breaking of a cross-head or putting in new sheets in the boi

and some very simple things that they put in and make a long string of extraordinary repairs. That seems to me to be unfair. It is simply keeping up repairs. Then, as stated in that report, if a new engine is bought to replace an old one, it seems to me only the difference between the value of the new engine and the old one should be charged to construction, but it should be charged to repairs—the keeping up of engines. If my superintendent takes five or six old engines and breaks them up and buys a half dozen new ones, and charges it to construction, it leaves a fair chance for years to come for me to make a good showing for keeping machinery in order; but if I am obliged to charge that to repairs, as it should be, it is another and very different thing.

Mr. Keeler, Flint & Pere Marquette Railroad—I move that the recommendations of the Committee be adopted to get the sense of this Convention.

Mr. Hayes, Illinois Central Railroad—Before that question is put I would like to say a word or two. This subject of uniformity of mileage sheets has been a knotty question with me for years, and I have had a good deal of correspondence both with our president and superintendent upon the subject. They have at times said to me, "Why can't you run as many miles on your road to a ton of coal as that gentleman runs? Why can't you do your repairs as cheaply as he does? Why can't you run as cheaply per mile for wages of engineers and firemen?" All these different questions that enter in to make up the sum total of our mileage sheets have been asked me. I simply say to those gentlemen, "Let us have a uniform system, and then I am willing to compare notes with any other road under similiar circumstances. Now I know of some roads, gentlemen present here, that have allowed from one hundred and fifty to two hundred and sixteen miles to a ton of coal. Now every gentleman present knows as well as I know, or as you know, that no engine will run that number of miles, yet that appears upon their sheet and enters into the sum total of the cost of running their road. How can you or I compare with such roads? Unless we bring this thing down to a uniform system we never can arrive at any conclusion, and the consequence will be that the publication of these monthly sheets will be entirely swept out from the railroad community. In regard to the purchase of new engines, or the rebuilding of old engines, it reminds me of the story of the old lady that had a knife that had been in the family for two hundred years. The handle got broke at one time and there was a new handle made to it; then the blade wore out and there was a new blade put into it; but it was called the same old knife that had been in the family for two hundred years. That is the way we propose to keep up our engines, and the way we have is to call it "maintainence of engines." When an engine comes on to our road we propose to maintain it from the day it comes on to the road until the road sinks into the earth. That seems to me to be the proper plan. I make no objection to the recommendations of this Committee. I think it is pretty nearly correct;

it differs a little from the system we have heretofore adopted in regard switching engines. The system we have adopted heretofore has been to all them six miles an hour for every hour while on duty. That does not incl the dinner hour; and, after the regular day's work if they work more, we all just in proportion to the number of hours. If they work twenty hours allow them twenty; if they work ten we allow ten. In computing that find at the end of the month, in allowing certain engines—particularly th switching passenger trains—sometimes they will make one hundred and fi to one hundred and eighty miles to a ton of coal. I know that is too mu and consequently I have adopted the rule of allowing eighty miles to a of coal; if it exceeds that I cut the miles down to that standard, and hence will find some of our switching engines will average eighty miles to a to coal. Others will not average over forty. The engines run from Chicag South Bridge, and it is a heavy pull, and they will consume about the sa amount of coal that an engine would pulling a regular freight train. He you will find, if you allow them six miles while on duty, there will be a g variation, and any road that does a large amount of light switching will compare favorably with one that does a large amount of heavy switching, consequently you will not arrive at a fair comparison with the different ro It seems to me you should adopt a certain system where you burn coal wood, and let the miles for light switching be proportioned by the amoun fuel consumed, and where you are doing heavy switching you may take y six miles an hour if you choose. In regard to the allowance for switching the line of the road, it seems to me you could get at a fair conclusion by adoption of an instrument for recording mileage. I do not know anyth about them, but I have seen them on steamers, and I believe they are pr correct. If a road could have one or two of those, and try one upon e class of trains, it would show about the proportion of miles that each t makes, you need run it but a trip or two to ascertain that, and after you h done that put it on another class of trains. We have been in the habi allowing for our engines running way freights nine miles to one hun and sixteen, which is about seven per cent., or somewhere along th That has been the rule for a good many years. Then, running thro freight, starting from Chicago and running to Champaign, or Champaig St. Louis, or St. Louis to Chicago, where they run through freights we a the miles between the point of starting and the point of destination. I tl that is fair and proper. If we compute this on the same basis we can ar at a fair comparison and at a fair conclusion, but unless we do this you find this whole thing will be swept out of existence. Prior to coming h had a conversation with some prominent superintendents in relation to matter. In fact, I sent them a report the same as I sent to Mr. Wells, an quested that they would lay it before the Convention of Superintend

They promised me they would do it, but the superintendent to whom I sent the paper on coming to leave his office found he had mislaid it, and of course did not take it with him; but he told me he brought the subject up and they had requested us to adopt a plan, and if it was a feasible one they would take it up at their next meeting of superintendents and would request that to be adopted, or would make such changes as they thought necessary, and would request or instruct their master mechanics' to follow that rule. If they do that, if we can get the superintendents to take hold with us in this matter, we can then arrive at something that will be reliable. There is another question while upon this subject. We publish, all of us, our monthly reports. That is expensive, both publishing and mailing. Why not adopt some rule and let us send a copy to the Railroad Gazette or some other paper, and let them put them all into shape there and publish it to the world? That will save us a good deal of expense in sending these reports round. It costs us two, three, or four dollars every month for postage stamps to mail these reports off to the different roads in the country. It seems to me if we could hit upon some plan of that kind, whereby we could call that paper the organ of the Association, and let them complete and put these reports altogether so they would be intelligible, every one can compare without this expense of sending them out. I prefer printing ours, and giving each engineer a copy, so I can say to him, "Here is a copy of what you have done, and what every other engineer has done upon the road, and if you have not done as well I want to know why. You are both running the same kind of engine and upon the same class of trains." It strikes me if we could get hold of the matter in that way and have it published in some paper it would save some expense. However, that is a matter for the Association to consider, and it is of very little moment to the railroad companies.

Mr. MAYNES, Selma, Rome & Dalton Railroad—I agree with Mr. Hayes in all his remarks, but he has left out one thing I would like to have heard him make some remarks upon—that is, a better classification of expenses for repairs.

THE PRESIDENT—The question is on mileage.

Mr. HAYES, Illinois Central Railroad—I suppose it includes everything on that sheet; everything connected with the performance of locomotives published in the sheet.

THE PRESIDENT—I did not so understand it.

Mr. MAYNES, Selma, Rome & Dalton Railroad—I supposed it included the whole sheet. There should be a classification whereby each and every one can figure upon the same basis and charge repairs up from the same standpoint. On the column of extra repairs we can all differ. My own idea is to throw out that column entirely and charge the whole up to repairs, and then, coming down to the cost per mile run, let us show the whole thing. I don't know that I have any particular plan to suggest; I bring the matter

up to hear from some of the older master mechanics. I think it is an important question. It is to me. I consider myself a young member and would like to be informed. I would like to hear from members of the Convention, particularly men who have had the experience of our friend Hayes, on some classification whereby we can be governed by the same rule in charging up expenses.

Mr. ROBINSON, Great Western Railway—If Mr. Hayes will allow what he has said to stand in the form of a motion, I would like to second it.

THE PRESIDENT—There is a motion before the Convention now.

Mr. ROBINSON, Great Western Railway—In regard to computing the mileage, I think it may be useful to state the way we arrive at our switching service on local trains. We obtain the conductor's report of every train and the driver's report. If they agree we accept them; if not, each case is investigated. In that way we get the number of hours. On our switching engines we have this rule: The station masters have to report to the assistant superintendent the number of hours they require a switching engine to be on service. About once a month I make very strict inquires into the hours required by each switching engine, and by looking into the matter if I find any man is not fully employed, his case is brought before the superintendent, and the engine is sent home perhaps an hour earlier; so by keeping a strict lookout on the work done in yard service it seems to me engines will not be laying out doing nothing and filling up performance sheets. Engine drivers are apt to think that they can sit down on the engine and have a sleep, or read the newspaper, and have their time go on and get their wages and have the mileage reported; it satisfies everybody as far as it goes, but it is very incorrect so far as comparison is concerned. We are satisfied that the rule we have is a good one until we find a better one. The recommendations of the Committee I think are very moderate and very liberal and very much to the point. The subject, it seems to me, is very difficult, but not more difficult than it is important. The difficulty I see in the case is in each road comparing with previous statements. A master mechanic will take a position on a railroad where he has had perhaps three or four predecessors. The superintendent and president are very fond of comparing the result of this person's management with his predecessor's management, and unless he is very careful, if we begin to reduce the rate of mileage it would look bad for the reputation of the person in office. That will be a great objection to an alteration being made. I think it is very important that the matter should be recommended to the attention of the superintendents, that they may see the necessity of making the change, and if it is worth the expense the sheet could be got out in two forms—one for the use of their line and the other for the whole country. In that way we could get over the difficulty, and if we do that I think it makes a feasible way of overcoming a difficulty which

ight otherwise be considered insurmountable. In regard to construction ccount, my opinion in regard to construction and repairs is this, and I am rne out by the experience of the old country, and the same plan is in operion in Canada: We say if you destroy an old construction and replace it ith a new one, the charge to capital account, or what you may term conruction account, is the difference in value of the old construction when it' as new and the new construction. What was the old construction worth hen it was first put in? One thousand dollars. What is the new one going cost? Two thousand dollars. Charge to construction, one thousand dollars. I take an old tank house—they are always being pulled down—if I pull wn an old tank house worth two hundred dollars and put up a new one orth two thousand dollars, I would not charge eighteen hundred dollars to nstruction account, but I would say what was the worth of this when it was ut up. I would say one thousand dollars, and the difference to be charged capital is one thousand dollars, and I must charge old maintainance account ith the eight hundred dollars, for if I was to replace it as it was there is no harge to capital. Whatever increase of value I put upon it is charged to onstruction. The stockholders say, "If you go on increasing your capital account, by charging what belongs to repairs, in fifty years the line will e put down at double what it is worth; but if you confine yourself to charg-ng as the advance you have made over and above what originally existed, we hall all the time have the value of our money represented in stock in our ands." I wish to be clearly understood that it is the difference in value of he old construction at the time it was first built, and not at the time you were mproving it or putting up the new one. That applies to locomotives or any ortion of the rolling stock.

The Secretary—That is what is given in the report—the difference beeen the price of the old one.

Mr. Robinson, Great Western Railway—When it was new?

The Secretary—The difference between the price of the old one and the machine.

Mr. Robinson, Great Western Railway—What I say is the difference in e when it was new.

he Secretary—That is the report.

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—I wish to a word in explanation of that matter. It is my intention to state the e of the old machine when it was new, the same as Mr. Robinson suggests, if that is not embraced in the report, it ought to be. That was my inten-. We mean to charge to new account the difference between the old ene when new and the present new one. If the present new one is worth thousand dollars more than the old one when it was new, the five thoud dollars should be charged to construction.

Mr. HAYES, Illinois Central Railroad—Perhaps I could illustrate this question by stating that last year we sold an old engine after having rebuilt her. She was an engine that cost about seven thousand dollars originally. That was a good many years ago; fifteen or twenty years ago. We sold that engine for nine thousand dollars after rebuilding her. We then after selling her, went to work and built a new one which cost twelve thousand dollars; three thousand dollars of that new engine was charged to repairs. We sold the old engine for more money than it cost originally, and the difference between what we sold that for, and what it cost to build the new one, was what we charged to the repair account. There was one question I did not speak of before; that is, the wages of engineers and firemen running switching engines. We have upon our road three or four engines—

THE PRESIDENT—We have a report upon engineers and firemen which will come before the Convention.

Mr. HAYES, Illinois Central Railroad—This comes under the head of this report. We charge the wages of the engineer and fireman on one sheet. The wages of our switching engineers and firemen, where they are running day and night, we find, amounts to ten or eleven cents a mile, while with the engineers on the main line it is from five to six cents a mile. Hence it is necessary that we keep the mileage up on switching in order to compensate for that difference in pay per mile run. When we come to look at the pay of switching engineers it is enormous, yet we are allowing them very few miles. They will run for the whole twenty-four hours and not make as many miles as one running a train a day. That should induce us to keep the switching hours as high as possible.

The report of the Committee was adopted.

Mr. SETCHEL, Little Miami Railroad—Offered the following resolution, which was adopted.

Resolved, That the Secretary be instructed to communicate to the Association of Superintendents the action of this body in regard to the mileage of engines, and respectfully ask that it or some similar arrangement be adopted in order to secure a uniform system of mileage and charges to engines in monthly performance sheets.

Mr. JACKSON, Rome, Watertown & Ogdensburg Railroad—I now move that the alteration be made in that report which has been referred to.

THE SECRETARY—That report is just as Mr. Wells stated. I understand it as Mr. Robinson does.

The report of the Committee on the Application of Compression Brakes was then taken up and read by the Secretary.

REPORT ON APPLICATION OF COMPRESSION BRAKES.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, to whom was referred the subject of "Application of Compression Brakes," having received thirty-three replies in answer to circular questions sent out by your Secretary, beg leave to note that there is evinced great interest in the minds of the master mechanics of this Association in all inventions and application of brakes that will tend to lessen the danger of the traveling public, and by their use prevent accident and loss of life.

Twenty-one master mechanics report as having in use on their respective roads compression brakes, eighteen have in use the "Westinghouse Atmospheric Brake," one the "Creamer," one the "Olmstead Electro-magnetic," and one the "Electric;" no name given of the latter—either of road or brake.

Mr. Setchel, Little Miami Railroad, in his elaborate and detailed report in answer to your Committee's inquires, says: "That they have sixty cars equipped with the Westinghouse air brake; have been in use one year and work uniformly well; and cites a case of his own personal observation where both life and property were saved by the use of this brake, and makes note of several other similiar cases; that in his opinion when the subject of brakes of this kind is thoroughly examined, there will not be found as one of its advantages any diminishing in wear of wheels, etc. The 'Loughridge Brake,' formerly in use on this road, proved worthless and was thrown aside." Mr. Setchel favors placing the braking power in the hands of the engineer, though at the same time does not advise the abandoning of the hand brake or brakemen. In conclusion he says, "that a train can be stopped with the Westinghouse air brake before the brakeman can get out of the car," yet there are many improvements that can and *should* be made.

Mr. Coolidge, Fitchburg Railroad, reports twenty-one cars already equipped and twenty more being equipped with the "Westinghouse," and have been in use three months, and consider them reliable. No perceptible reduction of wear of wheels noticed, and is not in favor of using brakes controlled by engineer entirely.

Mr. Skidmore, Louisville, Cincinnati & Lexington Railroad, says: We have in use on our road six express, seven baggage, and eighteen passenger cars equipped with the Westinghouse, in use five months and so far as able to judge for the length of time consider it reliable—has prevented the killing of stock many times. Had in use about twelve years ago a brake (Moor's) controlled by engineer; abandoned on account of chains breaking under cars. Is in favor of a brake to be used in case of accident only to be controlled by engineer.

Mr. White, Evansville & Crawfordsville Railroad, reports eleven cars equipped with the Westinghouse, in use four months, with seeming good results, and says: "The time we have had them in use will hardly justify a report on them as yet."

Mr. Tier, Lake Shore & Michigan Southern (Toledo Division), reports: "Have had the Westinghouse brake in use ten months; are very delicate and need close attention." Does not favor the use of a brake to be used in case of accident only by the engineer, but prefers to place the braking power entirely in charge of engineer.

Mr. Britton, White Water Valley Railroad, reports all of its passenger equipment equipped with the Westinghouse, and it is perfectly reliable; preventing the killing of stock a daily occurrence, and will pay for itself in a very short time for this purpose alone, and has never failed with them. The "Creamer" brake was in use formerly could not get the brakemen to attend to it properly. It was used quite successfully, however, for some time. Prefers the brake power should be placed in the hands of the engineer at all times. In conclusion says: "I am much pleased with the working of the Westinghouse brake."

Mr. Griggs, New York & Oswego Midland Railroad, says: "We have the 'Creamer' brake on fourteen cars; have heard of their application by my engineers when they have saved much property and possibly, life; are not always reliable, as brakemen neglect to have them adjusted and wound up ready for action." Is in favor of placing the braking power in control of engineer.

Mr. Boon, Pittsburgh, Fort Wayne & Chicago Railroad, reports "We have in use on all our passenger cars the Westinghouse air brake, about one hundred and thirty cars; and since using the air brake our defective wheel account has fallen off fully seventy-five per cent."

Mr. Jauriet, Chicago, Burlington & Quincy Railroad, reports seventy-five to one hundred cars as equipped with the Westinghouse, and gives as his opinion, "that the wheels wear out faster."

Mr. Hill, Erie Railway, reports as having in use on one of their local trains the brake known as "Olmstead's Eclectro-magnetic Car Brake," which has given perfect satisfaction, and he believes has many advantages over any other brake. Unlike other brakes it can be applied from any part of the train; from the engine, baggage car, or by the conductor in any one of the cars. With this brake every car is independent; consequently, if any one should get out of order, it does not affect the efficiency of the brake on all others. Mr. Hill reports one case where this brake prevented a serious accident, and to his knowledge it has never failed to work well at all times. Is strongly in favor of placing the braking power entirely in the hands of the engineer.

Mr. Philbrick, Lawrence, Leavenworth & Galveston Railroad. That their road is about to equip with the Westinghouse brake.

Your Committee, having given a limited number of extracts from different reports received, beg leave to more particularly ask your attention to the synopsis report hereunto attached, wherein is noticed under their respective heads the opinions of the few who have seen fit to reply to your Committee's inquiries. They would also add in their own connection that the conclusions arrived at are: That in the use of the compression brake serious accidents have been prevented, and both life and property saved.

In regard to reduction in wear of wheels, etc., opinions differ, as will be observed by reference to reports from Mr. Boon, Pittsburgh, Fort Wayne & Chicago Railway, and Mr. Jauriet, Chicago, Burlington & Quincy Railroad. Your Committee would conclude that the braking power should be placed under entire control of the engineer, though at the same time not by any means advising the dispensing of the ordinary hand brake and brakemen.

Respectfully submitted,

A. MITCHELL,
CHAS. GRAHAM.

SECRETARY'S LETTER ON COMPRESSION BRAKES.

A. Mitchell, Esq., Chairman of Committee on Compression Brakes:

Dear Sir—We have the Westinghouse air brake in use o road on all passenger trains (about sixty cars). It has been al year since the first was put on, and on *cars* it works uniformly It requires but little more care than the ordinary hand brake. air cylinders require a little oil often, in order to prevent the brake sticking after being put on, and al-o to prevent the use of too air in applying them. This sticking, or failure of the brake to quickly, is to some extent an objection in approaching wood an ter stations, where it is required to stop at a certain point; b making ordinary stops at stations, where that exact nicety is no quired, the air may be let off before the stop is fully made, an motion of the train will in a great measure relieve the tenden stick. I think it may be safely stated as a fact that with the req amount of air in air drums the brake works well. The difficulty, present constructed, lies in the failure of the auxiliary engine wo the air pump to work regularly. When everything is nicely adj and well oiled, it works well. But to keep it in this fine wo order is more than it is possible for the engineer to do at all t and frequently it is necessary to start it by hand several times bet stations to keep up the supply of air. This takes the attention o engineer from the track, and is extremely dangerous. This can, ever, and should be avoided. There is no occasion for this co cated piece of machinery to work an air pump on a locomotive you have any motion desired, and where the power required to it will operate as a retarding force to the momentum of the trai thus avoid the loss of power necessary to work the present st pump. It is claimed as an objection to this, that the air pump be independent, so that the air reservoir may at all times be ch ready for use. I do not think this point is well taken inasmuc every engine will run far enough and occupy a sufficient lengt time in doing it to fill the reservoir with the necessary amount o before starting with the train, and it would be difficult to imagi case where air would be needed when it could not be supplied pump worked by the engine in motion.

The Westinghouse Air-brake Company should see that this really valuable brake is relieved of this incubus as soon as possible. As to the saving of life and property by this brake, I do not hesitate in the least to say it has done both of these since first applied on our road. I will mention one instance where it saved *property* and possibly LIFE. The latter, of course, can not be positively known. By an oversight in the conductor of a fast passenger train in not informing his engineer that the switch at M. would be opened for them to enter a side track, meet and pass an approaching train, the engineer, having sufficient time, concluded to run by the station and back in on the other end of the switch. As he approached the station he applied the brake to see if all was right, merely taking up the slack of train, and then letting it off, and as he did so he saw the switch was open and cars standing on the track ahead of him. He applied the brake. The passengers surged forward in their seats and remarked, "Something has happened." Being on the train, I stepped forward to see what was the matter, and found the engine broken loose from the tender and standing about fifty to seventy-five feet ahead of the train, where it had run into some cars, breaking the pilot and doing some other slight damage. The train had not touched the cars, and the engine had been snapped, like the cracker off of a whip, from the tender and received all the damage that was done. There is no doubt but that in this case both property and lives were saved by the use of this brake; and there are many other instances—if the truth could be known—where accidents have been prevented. And on the other hand, there is danger in the use of this and all other brakes controlled entirely by the engineer. For example, if in running a fast train on a down grade the engine alarm sounds, the train must be stopped. It may be that a car is off the track; and if so, the sooner the train is stopped the better. Many cases might be cited to show that if the train had been stopped soon enough it would have been saved from going down the bank, or into a bridge, as at Carr's Rock, Angola, and recently on the Columbus, Chicago & Indiana Central Railroad, where the train ran down the bank only after running far enough to have stopped twice had the brake connection not have been broken, killing the fireman and fatally injuring the engineer. But suppose, instead of any of these, that the alarm sounds

and the train has separated. The bell's wild antics may say stop, and the brake is applied and the train is telescoped. This is not imaginary. Trains are often parted in running, and if in the night, it is difficult to tell whether the train has parted or a car off the track, or a refractory passenger to be ejected is the cause of the alarm. Two accidents of this kind have happened with us within the last year, but fortunately resulting only in a few broken platforms and draw bars. Another accident was prevented by the alarm failing to sound as the train parted, and the engineer discovered it by the working of his engine, after running some distance. A number of accidents of a more serious nature have occurred on connecting lines from this cause, which, I presume, will be reported to your Committee by the proper authorities.

I am aware that it is claimed that the use of brakes of this kind diminishes the wear of car wheels, but I think when this subject has been thoroughly examined that this will not be numbered as one of its advantages. That the natural tendency of the use of the brake in the hands of the engineer is to make quick stops, I think will not be disputed, and he can not, like the brakeman with the hand brake, look and see when the wheels are being slid, and if the cars are empty they will slide easy, and *vice versa* if loaded. It is no uncommon thing in using the Westinghouse air brake to see the wheels of empty express cars sliding, while those of the loaded cars do not. But if the slipping of wheels were no more frequent than with the ordinary hand brake, in proportion to the number of brakes applied, the general wear of wheels must be greater; for with the Westinghouse air brake, as well as with all others controlled entirely by the engineer, the brakes are applied to all the cars on the train, whereas with the ordinary hand brake it is never applied to express and baggage cars, and frequently to not all the passenger cars; and the wear of course would be in proportion to the number of wheels to which the brake is applied. A number of roads that were the first to adopt the atmospheric brake applied it to the tenders of the engines as well as the cars; but it was soon found that the fact of the tenders being loaded only about one-third of the time caused so much slipping of the wheels that it made a considerable increased expense in keeping up repairs, and but few roads now use it in this way. Have

COMPRESS BRAKES.

Any case of saving life or property with this brake	Any case of loss of life or property with this brake	Any perceptible reduction in wear in wheels or other car repairs	Other kinds of brake that have been used	Why abandoned.
h; see elsewhere	No	Think it will not make any difference	Lockridge	Worthless
known	Not known	Not noticed	Not noticed	None.
es killing stock often	"	Not in use long enough to notice		
any so far	No	Not stated	None	
eral cases	"	Much less wear of wheels	"	
not state	Can not state	Not noticed	"	
" "	"	"	Brown's	Unreliable
vents killing stock	No	Think wheels wear longer	None	
report	"	Not stated	Not stated	
least four cases	"	75 per cent. less wear of wheels	None	
not state	Can not state	Not in use long enough to state	"	
	No	20 per cent less wear of wheels	"	
cases	"	Not noticed	"	
stated	"	Wheels wear out faster.	Three others	Not stated
ing animals almost daily occurrence	"	Find less flat wheels	Electro Magnetic brake, J. Olmstead's patent	Chiefly through mechanical defects
stated	"	Think should not make make any difference	Not stated	
es killing much tock	"	Uncertain	Creamer	Brakemen would not attend to it
	"	Not noticed	Lockridge	Chains breaking, etc
		Can not state yet		
	Not known	Not noticed any	None	
	No	Not stated	Not stated	
	"	No reduction, and increase of repairs		

ad some little experience with the Loughridge brake, but it has een thrown aside as worthless. I have seen in my experience othing to compare with the Westinghouse air brake.

I do strongly favor and urge the adoption of the practice of putng the braking power entirely in the hands of the engineer. I ould not advise doing away with the hand brake or the brakeman, ut the braking can be done ordinarily better by the engineer, esecially in the night; for he alone has a proper conception of the peed of the train, the condition of the rail, and the distance within hich he must stop his train. In a case of extreme danger a train an be stopped with the Westinghouse air brake before the brakean can get out of the car; yet this is in its infancy, and there are any improvements that can and *should* be made, but it is undoubtdly the true principle, and it *must*, it is *bound* to succeed.

Very respectfully,

J. H. SETCHEL,

Master Mechanic Little Miami Railroad.

Mr. Boon, Pittsburgh, Fort Wayne & Chicago Railway—The statement ade in reference to the wear of wheels, which has not been sustained by y other members of the Convention, I wish to corroborate. On the Fort ayne Railroad the Westinghouse air brake was put in April, 1870, and as run during that summer on fast trains. We tried it on trains making obably the fastest schedule time made in America. After we commenced ing them I noticed a decrease in the return of defective wheels. There a complete record kept of every wheel put on the road; the time it is t in, when it is taken out, and the cause of removal. I noticed in the nthly report a great falling off in the number of condemned wheels, and visited the shop to inquire why there was such a decrease in the number, d I became satisfied it was from the use of the air brake. Our trains make mileage of three thousand miles per week, and before we commenced using e air brake we would average twelve hundred new wheels a year. Since have used the air brake we have averaged about four hundred. That is l we used last year. There has been a continuous falling off. During the nths of April and May our passenger business has been extraordinarily avy. During the month of April, out of the passenger stock, there was e pair of wheels taken out—one defective flange. During the month of ay there was one pair taken out. If it is not caused by the air brake I n't know how to account for it.

Mr. Hayes, Illinois Central Railroad—I would like to ask Mr. Boon

whether his road is now using the same make and pattern of wheel that the were before the adoption of the Westinghouse brake.

Mr. Boon, Pittsburgh, Fort Wayne & Chicago Railway—Our road using the same wheels. All the wheels are made by the Ramapo Whe Works; no other kind of wheel used.

Mr. Setchel, Little Miami Railroad—I am willing to admit all the pe fections of the Westinghouse air brake, but I don't think the saving in tl wear of wheels is one of them. I will tell you why. In the first place tl Westinghouse air brake is applied generally to all the cars in the train. using the ordinary hand brake it is seldom or never done; you carry one two brakemen and brake on perhaps two or three or four cars in the trai and that is all. On the baggage, express, and very often on an extra pa senger car or two, there is no breaking done at all. Certainly, allowing th it does as well, so far as the saving of the wear of wheels is concerned, compared with the hand brake, it must have a falling off, from the fact th it is put on more wheels on the train. Then, on the other hand, you can n watch the brake; you can not watch its action as accurately as you can t hand brake. With the hand brake the brakeman puts on the brake a leans over to see how it is working, and after he has tried the brake once twice he knows when he is sliding the wheels and when he is not; a when he is sliding them he lets it off a little; but with the air brake t the natural tendency of all engineers is to come into the station with a r and make a quick stop. Every engineer who knows he has a reliable bra is desirous of making quick stops. I have noticed it two or three tin coming from Cincinnati here, and have seen three or four wheels sliding the train. I can not see how this helps the wear of the wheels any. It is more wheels in the train and the engineer can not see when he is sliding wheels, and therefore it seems to me the wear must be greater. Then, ag there is another thing: On our fast passenger or through trains there a great many express cars drawn. If the brake is equipped to properly br on a loaded car it will slide the wheels on an empty car, and it is gener on all the cars in the train. Again, it is placed on some roads on the ta The tanks are run about one-third of the time about one-third loaded, whenever the tank is not loaded, unless the brake is applied very li it will slide the wheels. In fact I know of a number of roads where in using the brake they put it on the tenders and have since taken it off. brake was supplied to me and put on tenders, but I objected to it v strongly and I have got the brakes on hand. I would not put them on un any circumstances, unless ordered by the superintendent, which I have fears of, or any other superintendent who has examined the matter carefu

Mr. Elliott, Ohio & Mississippi Railroad—I differ with Mr. Setchel regard to the wear of wheels from these brakes. I am satisfied the whe wear longer because the brake is applied to all the wheels in the train;

that is not the point that I think of most myself in regard to this brake. The principal thing for us to reach is to find out which is the best and most reliable brake of all the brakes that are in the hands of the engineer. The time seems to have arrived when it seems to be almost absolutely necessary that we should have a brake in the hands of the engineer. Three years ago there was not anything of the kind in use; now there is one kind or another on trial on all the roads in the country. On our road we are trying three different brakes that are in the hands and under the control of the engineer, and so far as the wear of the wheels is concerned there is but little difference. We have the Westinghouse air brake, the Goodale steam brake, and a brake operated with one cylinder under the tender, running through the train with a chain, that is doing good service. The whole question seems to me to be which we can rely most upon, so when we want a brake we shall be sure to have it. We have been using the Westinghouse brake ten months on two of our through trains and it has given very general satisfaction—however it has failed at times. It would run perhaps three months, and there was not such a thing as failure, and then the air pump would begin to stop. Of course we could hardly account for it. Then it is a rather complicated piece of mechanism. We commenced having trouble with them at that time and have had more or less trouble since. However, as a general thing, it works well, and my impression is there is a great saving in the wheels if nicely adjusted. You can apply just sufficient force not to slip your wheels—that is what we want to avoid—and there is always more or less of that in the hands of brakemen. There is more or less setting them up as tight as they can set them; but there is a limit to the air brake. I believe this subject of brakes was not continued until next year. I think it would be well to continue the Committee for another year on this subject of power brakes, and I would make that motion if it is in order.

Mr. HAYES, Illinois Central Railroad—Before the Chair puts that question I would like to ask whether it cuts off all discussion at the present time?

THE PRESIDENT—No, sir.

The motion was agreed to.

Mr. HAYES, Illinois Central Railroad—I would like to say a word or two in reply to our worthy Secretary in regard to the wear of wheels. This, however, is more theory than from practice. We have just adopted the Westinghouse brake upon our road, but have not got it fully in use on all of our trains; but I can readily see that the Westinghouse brake, or any other brake under the control of the engineer, worked by power, that is completely under his control, that can be so regulated that you can apply the brake to every wheel in the train, will cause less wear and tear to those wheels than when it is applied by unskillful brakemen who are liable to slide the wheels upon two or three cars at a time. Now if you start with the tender of your engine and apply the brake there, and graduate your power then in the beginning just in proportion to the weight held upon that tender,

when it is empty, how are you going to slide those wheels? Do t
same upon every other car in the train, and the result is the pow
exerted upon these wheels is three times what would be exerted by or
nary brakemen, and yet you need not slide the wheels. That bei
the case, I can see why wheels will wear a great deal longer. That
merely my theory in the matter (not having had any experience); but I kn
that with unskillful brakemen we have had to put in wheels that cost twe
dollars apiece after running one trip; but with the Westinghouse brake,
far as we have used it, I have not seen a single wheel spoiled. If by unsk
ful workmanship you get your brakes graduated wrongly and apply too mu
power you can spoil any wheel. I can't apply a brake half as strong as so
of the Irish brakemen that are employed. They will slide the wheels eve
time. I think the theory of the Secretary is incorrect, and I think you w
find the experience of the gentlemen here will contradict it. I think
having a brake perfectly under the control of the engineer it can be so
ranged and so graduated that you need not spoil a wheel in twelve mont

Mr. FLYNN, Western & Atlantic Railroad—I have had some experie
in the use of the Westinghouse brake; we have had it for six months on
our passenger trains, and I must agree with Mr. Hayes. We find no di
culty in spoiling wheels, and less difficulty than under the old system of
hand brake. Our worthy Secretary spoke of the tender; I found that di
culty at first, but it was very easily overcome. I have changed the woo
brake to an iron-shoe brake and from that time have had no difficulty wh
ever. I am in favor of having the brake under the control of the engin
I have cautioned my engineers in going into stations, or when they used
brake to prevent killing stock, not to throw it on with such force as to s
in going a very short distance. They are well pleased with the bra
At first they had some objection to it; it was a new thing to them and a n
thing in our country. So well satisfied are we with the Westinghouse br
that every road in our section has adopted it. So far as my observat
goes it is the best brake I have known, and I am very well pleased witl

Mr. SETCHEL, Little Miami Railroad—I intended to say just enough
excite the indignation of the advocates of the Westinghouse air brake
create discussion. Last year the subject was brought in here and pas
over without a single word being said about it. We took it and swallo
it right down as the best thing. I believe in the use of the brake; I
lieve that it is the best thing that has been used, but I wanted to h
some discussion. I wanted to hear all sides of the question. We hav
statement from Mr. Hill in the report that he has a brake in use on a lo
train on his road that has proved itself perfectly reliable; that it can be
from any car in the train without affecting its operation on any other
in the train; and if that is the case it is possible that that may be equa
the Westinghouse air brake; it looks a little like it, I confess, but un
that brake is equal to it I have never seen anything that is. I like it.

have had it in use eighteen months. I know it is worth the trouble and cost in saving stock alone. I was on a train not three months ago where I have no doubt it saved the lives of passengers and a great deal of damage to the rolling stock. In approaching a station, the engineer felt his brake to see that it was all right, merely taking up the slack of the train and then letting it off; as he did so he saw a switch was open and cars standing on the side track, and immediately applied the brakes again. As he did so, the slack of the train, being concentrated on the engine, snapped the engine from the train. The engine went forward and run into the cars, smashing the pilot and front end and smoke stack, but the train and tender were not hurt. When the engine parted from the train it broke a two and a quarter inch bolt by the application of the brake. There is no doubt in that case lives and much property were saved. I have often been running upon engines myself when I was satisfied that horses and cattle would have been killed if it had been for the Westinghouse brake. But I think that it is not becoming for us to take an important subject like this and swallow it right down, and not say a word about it. So far as the wear of wheels is concerned I believe just as Mr. Hayes says, that it can be graduated so that it will save wheels in the wear, but on some roads I am satisfied it is not properly put on. In coming here I stood on a train between the back baggage car and the front passenger car, and in three stops out of four all the wheels on those two cars were sliding when the train stopped; that is not the fault of the brake at all, but it is the tendency that engineers have to rush in and make quick stops, applying the power all at once. That is the trouble. If you apply the brakes to a train in season you can stop at the same point, the brake being applied to a greater number of wheels; but if you apply it when you have got only half that distance in which to stop, you have got to put on double the power to stop your train, and you slide your wheels; but the brake can be so arranged that it will not slide the wheels, and put in the hands of careful men with positive instructions that they shall come into stations slowly, and in this way it can be made a good thing in saving wheels.

Mr. Robinson, Great Western Railway—I quite concur with the Secretary in his position. I think it would be a good thing for some of us to imagine that we are opposed in argument to draw the members out. For my part I have watched these brakes and studied them with a great deal of interest. We have tried two or three brakes and have thrown them all away, and we are waiting for some other roads to take their share of the xperiments before we decide. There is only one point I wish to refer to now which it may be useful to speak of, and that is this: If I had any doubt (I am not now speaking of the Westinghouse or any other particular kind of brake) that wheels were going to be skidded under the tender or the baggage cars or any other part of the train, that is if the cars were to be loaded at one

time and empty at another, I would regulate the brake so that it could not skid them when the cars were loaded or empty; that is to say, if the brake is regulated as if they were all empty they could not skid the wheels on the train whether loaded or empty. I think a brake where the power is applied to all the wheels is more beneficial than where the brakes are applied to two or three cars, skidding the wheels, because it would be a partial braking on every wheel instead of wholly braking on two or three wheels. As this can be done by the Westinghouse brake it is only a question of mechanical skill, and I think it is unbecoming for us to think that we can't control a simple mechanical appliance of that kind without fearing the result on our rolling stock.

Mr. KEELER, Flint & Pere Marquette Railroad—The Westinghouse brake has been used six or seven months on our road and during that time has never failed. I know that it has saved a great deal of property, such as cattle and horses, and probably many lives. We have had a collision since the report was sent to the Committee from our road, where we know if we had not had the air brake we should probably have killed some passengers and the cars would have been telescoped; but as it was, they stopped and never broke a thing, while the engine was completely wrecked. I lay it all to the application of that brake. Before we adopted this brake we tried the Electric brake. I had some correspondence with Mr. Hill in relation to it; he recommended it very highly. We put it on to one train of four cars alongside of a Westinghouse brake, running on the same train, or the same class of trains (I mean the Olmstead brake), and we did not make a successful trip in the trial. I think that it was owing to some mechanical defect in the machinery. I don't suppose but what the Electric brake can be made to work, but that was the result of our experiment, and we adopted the Westinghouse brake and have it on our entire equipment. So far as saving wheels is concerned, before putting it on I don't think there was a week but we had to change wheels; after we had adopted it we stopped with less power on each wheel, avoiding the sliding, and we have not changed one wheel from that cause. I don't see any objection to trying other brakes. I would like to hear from gentlemen who have had experience with them.

Mr. EDDY, Boston and Albany Railroad—I would like to ask one question, not having had much experience with the Westinghouse brake; I would like to ask the question, If they are not somewhat complicated, and if the engineers don't find it constantly annoying them to keep the pump in repair, and if, in consequence of that, engineers on several of the roads have not asked for more pay?

Mr. BOON, Pittsburgh, Fort Wayne & Chicago Railway—After two years' experience, I can state for the information of the gentleman that any ordinary mechanic, after a few days' trial, can thoroughly understand the whole management, and as for the trouble to the engineers I have not got a man

running it but would run for ten dollars a month less rather than have it taken off. When I first put them on I put a man on to run them until they got used to them, and the men now take care of them themselves without any trouble or watching. They take care of them as much as any other part of the machinery, and the men who now run the passenger trains, if anything happens to their air brake, will not take their engines out until it is fixed. When we first put them on we put them on to two engines running fast trains; the two engines running opposite had none on, and the men came and offered to pay half the expense if the Company would put them on to those engines. There is no train permitted over our line except air-brake trains. We find that men make better time. The States of Indiana, Ohio, Illinois, and Michigan have stringent laws about crossings; we are obliged to come to a dead stop at every city of two thousand inhabitants and are obliged to stop at railroad crossings; if we don't it is an offense punishable by imprisonment. With the old hand brakes the men commenced stopping two miles from the station or crossing; now they run up to the crossings and stop within the legal distance, two hundred feet. We find we can run our train the distance of one hundred and forty-eight miles twenty minutes quicker than with the old hand brakes, and it makes a difference of forty minutes in our running time on the road.

Mr. Hudson, Rogers' Locomotive Works—Some time ago, by invitation of the superintendent of the New York and New Haven Road, I took a trip over that road for the purpose of seeing and reporting the working of the Westinghouse air brake which they were experimenting with. I rode upon the locomotive and watched its operation, and rode upon the cars and watched the operation, to see that they didn't slide the wheels. Now I conceive that it is possible to arrange that brake so that the wheels can not be slipped. Every engineer knows when he slides the wheels. The resistance, so far as stopping the train is concerned, is less than when he does not slide them, but holds back all he can without sliding them. Every brake ought to be arranged so it can be brought to a point that will not slide the wheels, and the Westinghouse brake succeeds beyond any other brake which I have seen in doing that with certainty every time. Where it is not done it is only a matter where it has been overlooked in putting it on and properly adjusting the leverage so that the wheels shall not be slipped. After watching the operation on that road and satisfying myself about all the points in relation to it, I made a report to the superintendent that in my opinion it was decidedly the best brake for railroad purposes, taking everything into consideration, which it had ever been my opportunity to witness or become acquainted with. They felt as though they wanted all the information they could get; they had some little trouble at first with the pump not working right and with the air chamber not being regulated so they could get quickly a certain amount of pressure and no more, and they had trouble in a good many

little things; however, they were things that were easily obviated, and I have no doubt at all, so far as I have seen brakes, that it is at the present time the best brake in use; and if I was about to run a locomotive, as I have done in former years, I should prefer it to any other I know of.

Mr. EDDY, Boston & Albany Railroad—One gentleman has answered the question which I have asked, for which I thank him very kindly. I asked the question and had a motive in asking it, and my motive in asking it was that we have had some little experience with the Westinghouse brake, and some three or four men that are running it have demanded or urged very hard that they should have extra compensation for running and taking care of that brake, and are very indignant that they do not get it. I am well aware of one or two other roads that have had the Westinghouse apparatus and have laid them aside, or have not put them on, because of the understanding that men have demanded more pay where they have the Westinghouse air pump to take care of.

Mr. SHAVER, Pennsylvania Railroad—We have our road equipped with the Westinghouse brake; we run it on all our trains; it is on some twenty-seven engines on my division, and we have few men on our road that would be willing to run without it. I have had them tell me time and again within the last six months they had rather pay ten or fifteen dollars a month out their pockets than be without it. So far as the trouble is concerned in taking care of the pump we have none; all you have got to do is to understand the thing and teach your men how to use it and they can do it. We did not have any trouble with it.

Mr. COOLIDGE, Fitchburg Railroad—There is one point in relation to the matter that has not been touched upon; a point that I think ought not to be left out. In the report I am made to say that I do not believe in placing the braking power exclusively in charge of the engineer. I wish to explain that the road which I am connected with has used the Westinghouse brake for nearly a year; that road intersects, in going fifty miles, six different railroads, three of them double track roads; at three of them the trains stop at a point as near as they can get; they make their first stop at a point of intersection with these other roads. Soon after using this brake I thought I saw what might be a source of danger from using them; that is, with a train making these stops, being under the control of one man, if he should fail, it occurred to me, the results would be disastrous. I saw an illustration of this one day at one of our crossings. The train came up (it was an accommodation train of about seven cars) and when it got within fifty feet of the crossing it was going comparatively slow, eight or ten miles an hour; of course I expected to see it stop without going any distance; I hardly thought it would go ten feet, but it gradually kept moving on until it went half way over the crossing. It occurred to me if that should happen with a train upon the other track the result would certainly be a loss of life. I mean

tioned the fact to our superintendent and he immediately issued an order that at these crossings the trains should be stopped by the brakemen, which regulation is in force now. That explains my part of the report. Our trains are wholly under the control of the engineer at other points except the intersection of other roads. Now it is generally conceded that the Westinghouse brake is more perfect than any other one we have in use. It has been more fully tested. We may find something better, but it is generally admitted to be the best at the present time. With that exception I think it is better to have the train exclusively under the control of the engineer. As to its efficiency, we will all allow if a train is controlled by five men, the engineer not only has the power of those five men but of ten men more. We saw some years ago on the Pennsylvania Road a train going twenty-five miles an hour stopped in going its length. We saw that demonstrated at Altoona and other points on the road; but if you put that power in the hands of one man, what is going to be the result if he fails from any cause whatever at such a point as the intersection of another road? Some gentlemen have stated to me that they had seen in the papers that an accident of that kind had occurred, I think, in New Jersey. That is all I have to say in regard to that point. Another point is in regard to engineers demanding more pay; I say that is of no consideration whatever; so in regard to the wear of wheels. This brake is intended for safety. The public demand it and will have it, and the expense of it is an after consideration. We are, as a body, trying to see what is the best thing. I don't say the Westinghouse brake is the best thing that ever will be, but I say that it is the best thing that has been so extensively tried and developed, and I think we will all agree that the best thing is what we want. The consideration whether the engineers demand more pay or not is of little importance. I think we shall find that intelligent engineers after using that brake will say, "I will not run if you don't give it to me." When an engineer has had the brake under his control, I think in ninety-nine times out of a hundred he will say, "I will not do without it," and will feel as if he was risking his life if he did'nt have it. In regard to the wear of the wheels, we might have almost an endless argument upon that. I certainly think, looking at it scientifically and mechanically, that we must admit it is better to stop a train with friction applied to every wheel just alike than to have a strong man here and a weak one there and one man in the baggage car smoking and another one doing his work. In regard to applying it to tenders, I grant it will be more work to make the locomotive repairs, but that is of no account. What matters it? We might as well wear out our tender wheels as our car wheels. On the road I am connected with it is applied to the tenders; it does make some work and wears out the shoe faster and wears out the wheels some faster; but I consider those things are of no account. The mere amount of wages and the wear of wheels I consider of no account compared to the safety; that, in my estimation, is the only consideration.

Mr. SHAVER, Pennsylvania Railroad—In regard to slipping wheels, we have some brakemen that don't appear to care how hard they draw the brakes if they only draw them up to the last notch—so with some engineers; but a good man on an engine will watch his gauge and put on two or three pounds of air, close his gauge, and put on again. Then when he slackens up he stops the whole train without sliding his wheels. A little instruction to the engineer in that respect would avoid a good many complaints if there was any cause for any in sliding wheels.

Mr. SEDGLEY, Lake Shore & Michigan Southern Railroad—On the road with which I am connected we have eighty or ninety engines equipped with the Westinghouse brake and two hundred and fifty cars, and we are making a mileage, with passenger trains, equal to about ten thousand miles per day. It has become a standing order, and I am not allowed to put an engine upon a passenger train without the air brake. As a matter of safety, with eighteen months' experience with the brake, we find it the most efficient and the surest way to stop our trains. We have never had an accident, but we have saved a very large number of accidents, when, had we been without the brake, it is impossible to say what the result would have been. As a matter of economy we find we make a large saving in wheels; instead of applying the brake to one-half of the wheels upon the train it is applied to all, and, consequently, we make a more efficient and reliable stop. Then, as regards expense, we find it is much cheaper to use the brake than it is to use men for stopping the trains. For a train of twelve or fourteen cars we were obliged to run three or four brakemen; now, on those trains, we run but two, so it is very easy to see its advantages as a matter of economy as well as safety.

Mr. SELLERS, Late Des Moines Valley Railroad—I would like to give you a little word of explanation in regard to the Westinghouse brake, which is this: I see by the remarks that gentlemen have made that all concede that the braking power distributed throughout the whole train is less destructive to that train than it would be if confined to only a portion of it; that is conceded. Whenever we have a mechanical problem to solve, we want, first, to take our hypothesis. Now we wish to produce a certain result, and in order to produce that we must have first a power known; next, an equal distribution of that power; and then, a perfect control of it; those are the only three conditions in the matter. With the Westinghouse brake you have a known, fixed power, a pressure of a certain number of pounds per square inch in your reservoir; you distribute that through the train by an elastic current of air, consequently each car does its own work. If one car does not do the same work as another, it is a defect of the mechanical working it can not be otherwise if it is in order, from the fact that this elastic current distributes itself.

Mr. PEDDLE, Indianapolis & St. Louis Railroad—I agree generally in the opinion of the gentlemen who have spoken in regard to the efficacy of the

brake, but I think we ought to criticise it in every way possible. I would say, in answer to the question of Mr. Eddy, that a short time ago we advanced the wages of our engineers. An application was made, and one of the grounds was that the engineers did the braking. I think, with the gentleman who has spoken upon that subject, that it is a very small matter; but still it is a fact. In regard to the expense of keeping up the brake, there is no trouble whatever about the engineer running the brake, but there is some trouble and expense in keeping up the brake; we find the pump apparatus is somewhat complicated. On our road—where we have fifteen engines and fifty cars—we find it takes one skillful mechanic about all his time to keep those pumps in order. We have been obliged to order extra valves, and keep them on hand for emergencies. In regard to the action on the road: A short time ago I made a trip on a road, and the first station we came to we run about a car length past the station. Coming to examine into it we found the rear sleeping car, coming from New York—it was then one hundred and sixty miles from St. Louis—had three or four holes punched into the hose where it had dropped down on to the coupling, and had worn through the rubber. The engineer had put on his brake at the right point, but the pressure diminished so fast he could not get the train stopped. We have had one accident from the brake. The train was a long one, and the coupling link broke in two; the bell was rung by the cord pulling, and the engineer, supposing that the conductor or brakeman had pulled the rope, put on his brake; the brakemen, not being called out by the usual signal, did not go to the brake, and the two sections collided. The starting signal now is one pull of the bell, and two pulls to stop the train, which partly obviates that trouble. I think I agree with the gentlemen, in the main, that it is the best thing that has so far been tried on railroads. I agree with them, but I think there are some defects in it. I understand there is a brake now in progress in Pittsburgh, which I think some gentleman will explain here for the enlightenment of the Association.

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—I want to make one or two statements in reply to the question of Mr. Eddy in regard to engineers demanding more pay for using that brake. We commenced the use of that brake more than two years ago, and we found that the engineers at that time expected to be paid something extra for attention to it; but after they had used it a month or two and become familiar with it and familiar with its advantages, and saw that they could not get along very well without it, they said nothing more about extra pay; and all the other engineers, running similar trains, requested to have it put upon their trains, and said nothing about extra pay. I know there is no one of them that would be willing, under any consideration, to dispense with it on any of the fast trains. Now in regard to the wear of wheels: In my own observation I can state that the saving in the wear of wheels, by the use of that brake, has been twenty-five to forty per cent.

We all know you can carry a given pressure in those reservoirs by a valve and allowing the excess of pressure or air to blow off; and wh quire to use the brake you have just the amount of pressure that The brake can be so adjusted that it will require nearly the entire pres air in the reservoir to slip the wheels; and in making any ordinary st gineer does not need to use the entire pressure, and consequently t sliding of wheels; but in case he is obliged to make a quick stop l on the entire pressure, and at the same time the wheels will scar and when there is such an adjustment as that on the levers of the saving of wheels must be considerable. Now, in the old applicati hand brake, we all know where there was one brakeman betwee he would do all the braking upon one car, until he had that set up until he had time to go and commence on the other car there w out of the two that was doing all the work, while the wheels of were doing nothing; but by the application of the air brake, or brake of that kind, that is avoided; the pressure upon every wh train is alike, and as a consequence the pressure can be less upon in a given time, to produce the same result, than if it is applied or half of the train. It can not be very new to the mind of every that an arrangement of this kind must far exceed in efficiency tl other arrangement that has been in use heretofore.

Mr. GREGG, Erie Railway—I don't get up to talk about the imp a better brake than the old-fashioned hand brake. I think alm intelligent mechanic in this room, I think the Association gene concede that we want a better brake than the hand brake; and whether the expense be more or less, will be compelled by the trav lic to introduce a better brake than the old-fashioned hand bra glad to know that we have a better brake already introduced. several patent brakes now in use throughout the country, giving m general satisfaction. I have no doubt that road after road, thro entire country, will be, in a short time, equipped with better brake old-fashioned hand brake, merely because the traveling public w railroads to do it, whether they will or no; and I trust that master have intelligence enough to carry this work forward until the ro supplied with better brakes. I have been pleased with the ingenu Setchel in drawing out this discussion by taking a false position; I was pleased that he did not allow that to go before the public as h My object in rising to speak here is to correct a mistake which wa regard to boiler sheets yesterday, in reference to drilling or punch

THE PRESIDENT—If there is no objections the gentleman can explanation.

Mr. GREGG, Erie Railway—Mr. Setchel's ingenuity suggested thought to my mind. I am made to say in the papers, thi

that I favored the drilling of flue sheets and of boiler sheets in place of punching them. Now I want the Association to understand that I favor no such thing at all, simply because I don't think there is any necessity for it. I don't want the Association to go away with the belief that I am going back and ignoring all my experience, for thirty years, in railroading; and hence I don't want the Association to believe that I favor drilling of boiler sheets. I simply said that the experiments made by that Committee proved that the sheets were stronger drilled than punched. That was all. I don't propose to go back thirty years or more and ignore all my experience, and commence where I commenced then. I don't propose to throw away steel tires and take up iron ones; I don't propose to throw away steel sheets for fire-boxes and use iron; and I think there are master mechanics here to-day that will live long enough to see the whole entire boiler made of steel in the place of iron, and will punch sheets instead of drilling them.

Mr. Elliott, Ohio & Mississippi Railroad—There is one other point that I desire to talk upon in connection with the Westinghouse brake, and that is the consumption of fuel in running it. How much fuel it requires in addition. I would like to hear some of the members on that point. On our road, without going into any fine matter in relation to it, we have thought it took about twenty-five bushels of coal to work the brake over our road, over the entire line; that would be one hundred and forty miles. That is something that should be taken into consideration as a matter of expense. I would like to hear from any of the gentlemen who have tested the matter.

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—It seems to me we should close the debate upon this question before we commence anything else.

Mr. Glass, Allegheny Valley Railroad—In reference to the brake referred to as having been got up at Pittsburgh, I will say it is a vacuum brake gotten up on the vacuum principle, and we have attained a vacuum of nine pounds and a half upon a cylinder twenty inches in diameter, giving us about three hundred and fourteen inches on the square of the head, equivalent to an atmospheric pressure of four thousand pounds, which is applied direct to the brake lever. The vacuum is created almost as instantaneously as pressure can be got into the Westinghouse air cylinders. It is produced by a steam syphon. When danger is seen, you draw the throttle—as you do of an engine or injector—and create a vacuum, and it is done almost instantly. We have tried it on our road on six cars and in a distance of three hundred feet, running thirty-five miles an hour, with a large engine we have brought the train to a dead stand; and with the same engine, on the same occasion, the engine with the throttle wide open, with a pressure of one hundred and twenty pounds, it was brought to a dead stand in an incredibly short distance. These are got up very cheap, and no doubt, will be very effective. I desire to make an announcement, that as many of the members as can take the

trip on Saturday will see it on the train that is being equipped for the occasion.

Mr. ROBINSON, Great Western Railway—There are a very large number of mechanics here to-day who are using the Westinghouse brake, and I would like to ask if the objection which I have heard against it, in regard to releasing the brake, has been overcome entirely? That is a serious point in the consumption of fuel. I have been told that, after the brake has been put on, when the train is ready to start, some of the brakes were found touching, and that there is a large amount of power required to overcome unnecessary friction. I am told it has been partially overcome on some roads, while others have not succeeded in overcoming it. It is a serious question, and I should be pleased to hear that it is entirely overcome.

Mr. GRANT, late of Rockford, Rock Island & St. Louis Railroad—I will state that Mr. Wilson, of Galesburg, has recently patented a valve by which he has entirely overcome that trouble, so that he releases it entirely and it is done almost instantly.

Mr. KEELER, Flint & Pere Marquette Railroad—In regard to overcoming the friction, we have adopted a little syphon to take the air from the reservoir, the same as a steam syphon. After the pressure has relieved itself from the cylinder you turn a little cock and in an instant every piston will go right back.

Mr. MAYNES, Selma, Rome & Dalton Railroad—We have heard of one or two different brakes here. The vacuum brake and the Westinghouse brake. I would inquire if any member has had any experience with the Goodale brake? We have not adopted any brake on our road, and have been in correspondence for that purpose.

Mr. FORNEY, Railroad Gazette—I would like to call attention to a little experience I had on a train equipped with the Westinghouse brake, and suggest whether some modification should not be made to meet that difficulty. Coming over the Pennsylvania Road a year and a half ago the train broke in two on a down grade; the engineer put the brakes on, and the rear cars ran into the front cars and smashed the platforms. It seems to me that is a little difficulty. I am not prepared to say there will not be something better than the Westinghouse brake; but I am prepared to say, so far as my observation has gone, that it is the best thing in use at the present time. This, it seems to me, is a little difficulty in which there would be an opportunity for persons to exercise their ingenuity to obviate it, if possible. I suggest it so people may be set to think of it.

Mr. GLASS, Allegheny Valley Railroad—The difficulty suggested by Mr. Forney has been provided for in this vacuum brake. They use a rotary pump in the caboose of the train, and by working that by hand, or working it from the axle, the vacuum is produced equal to that produced by the steam syphon, and if the train parts that can be applied and the train brought to a dead stand.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I would like to ask Mr. Glass whether that application to the rear of the train depends upon the attention of some one person there, or will it apply itself automatically?

Mr. GLASS, Allegheny Valley Railroad—It is intended that the conductor or rear brakeman or flagman shall look after that.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—Then if he goes to sleep or is not there to attend to it, it is not any better than if it was not there?

Mr. GLASS, Allegheny Valley Railroad—No, sir.

On motion of Mr. Chapman, the discussion on the subject was closed, and the Association took a recess of ten minutes.

On coming to order a paper was read by Mr. Nott, an associate member, on the Use of Fuel for Generating Steam.

USE OF FUEL FOR GENERATING STEAM.

BOSTON, June 10, 1872.

To the American Railway Master Mechanics' Association:

GENTLEMEN—I trust that all suggestions which may be submitted to the Association will find a kind reception; this reflection consequently gives me courage to submit the following remarks:

For some years I have given practical attention to the study of the economical application and the use of fuel for the generation of steam, and especially as applied to the use of the locomotive in its round of daily service, which I will endeavor to state to you in a concise manner and with the conclusion of the study of this important and interesting subject, endeavoring to gain facts, during the progress of practical trials.

I find that the more the water surfaces and spaces are increased, which come in immediate contact with the burning fuel—certainly when *combustion* is progressing—that the partially consumed fuel will, when in an imperfect state, as it always is after rising from the bed of fuel, invariably becomes an agent for injury to the iron, the moment it reaches the cooling surfaces of water, and the conduction of the heat and the generation of steam will be very much retarded and the efficiency consequently reduced.

The trials which I have made with the locomotive cover a period of more than twenty years, and have been conducted for the purpose

of ascertaining the best plan for overcoming the deteriorating effec of the cooling chambers of water around the locomotive fire-bo: upon the volatile fuel. I have, I trust, ascertained that to reac good combustion and a clean heat for the fuel, during the time o its transformation from the raw state on and above the grate ban that its after preparation must be between the top of the bed of coa and before reaching the flue entrance. The light disengaged fue must find room and time within the fire-box, and in that portio where there is an *intense white heat*, which is only in the central pa and away from the water surfaces. The volatile fuel retained in thi *hopper* of white heat, for the least applicable time more than a present, for mixture, will certainly produce a more clean heat.

I find that the direct course of the fuel from the bed of coal to th flue entrance is directly opposed to a good combustion.

The results of numerous investigations relating to the use of fue in the fire-box of the locomotive prove that the light products of a imperfect combustion, coming up from the bed of coal and after wards coming in contact with the surfaces between the heat and th water, must be checked in the central part of the fire-box; for a soon as they reach iron, protected by water, the opportunity for pro ducing a clean heat is over.

A column of light fuel, such as bitumen, smoke, etc., passin through the tubes will only act as a self-retaining movable con ductor. This body, in its passage through the boiler, masses, col lects, and retains the heat of an imperfect combustion, and as moves through the tubes produces a partial condensation, and th non-conducting qualities of this column retain the heat, which car not pass off to the water, however much the draft may cleanse th surfaces; it is non-conducting and holds the heat. To overcom this difficulty, the fire-box must be used as an arrester.

The raw coal, immediately after it enters the fire-box, at once pro duces non-conducting material. A plan that will *require* a very thi fire and allow the *air* to *come up* and pass through the intense hea and there be thoroughly mixed, will be of immense advantage, a the intensity of the heat, away from the cooling water surfaces, different from that of other than railway exigencies. An instan gained here is unlike that of any other way of generating steam.

I think that it is acknowledged that there is now scarcely an

time for *mixture*, free from the contaminating influences of the water surfaces. Time must be gained, but at a light cost, or there will be a balance of accounts.

The light fuel and the air must each exhaust the other and produce, as a result, a clean heat; when either is in excess, a poor result will at once be noticed.

It appears to me that the column of air admitted under the fuel is generally more than is needed for efficient application; as any excess coming from this direction will be of great disadvantage after reaching the space between the bed of coal and the flue sheet.

Any plan that can be devised for retaining the imperfect combustion will also be a check upon the extravagant use of fuel, as the moment this occurs the air will be more than supplied. One of the causes of the failure of the "combustion chamber" was owing to the contracted room and the close contact of the water spaces with the light fuel coming from the fire-box—the temperature of the water being so much less than that necessary for combustion that the light fuel is rapidly condensed and precipitated. All practical trials prove that the fuel, during its preparation for making steam, must be kept away from all parts of the boiler protected by water surfaces, as for some distance from the actual contact there will be a constant partial condensation of the fuel.

In the plain fire-box the products of an imperfect combustion are thrown against the *center* of the tube sheet with all its *force* and intensity, which is the very part where there should be uniformity of action. Here we find a weak part of the boiler subject to an immense heat and impure combustion. A remedy that will apply to the mixture and gaining of time in the central part of the fire-box must serve to modify the force of this column against the tube sheet.

The accumulated experience of the locomotive department of railway engineering is, that time for a thorough mixture must be gained, whatever may be the size of the fire-box—less for a long than a short one. In the use of a *long* fire-box there is a gathering of injurious gases when the tubes are reached; with the small one this gathering is not so large, but the mass of the products of poor combustion are more.

Truly yours, GORDON H. NOTT.

On motion of Mr. Hayes, the paper was received, and a vote of thanks returned to Mr. Nott.

The President announced the following Committees on the subjects presented for consideration at the next annual meeting:

Locomotive Boiler Construction—S. J. Hayes, Illinois Central; J. O. Losey, Louisville, New Albany & Chicago; J. B. Gregg, Erie.

Operation and Management of Locomotive Boilers including the Purification of Water—H. A. Towne, Hannibal & St. Joseph; A. H. DeClercq, Toledo, Peoria & Warsaw; H. Elliott, Ohio & Mississippi.

The Comparative Value of Anthracite Coal, Bituminious Coal and Wood for Generating Steam in Locomotives—C. Graham, Lackawanna & Bloomsburg; L. S. Young, Cleveland, Columbus, Cincinnati & Indianapolis; B. H. Kidder, Buffalo Division, Erie, Lake Shore & Michigan Southern.

The Construction, Operation, and Expense of Maintaining Continuous Train Brakes—J. M. Boon, Pittsburgh, Fort Wayne & Chicago; J. Johann, late of Missouri Pacific; W. S. Hudson, Rogers' Locomotive Works.

Relative Cost of Operating Roads of Gauges of Three Feet Six Inches or Less and those of the Ordinary Four Feet Eight and a Half Inch Gauge—J. T. Robinette, South Side; J. U. Eastman, Nashville & Chattanooga and Nashville & North-Western; W. B. Smith, South Carolina.

The Construction and Operating of Solid-end Connecting Rods for Locomotives—J. Sedgley, Lake Shore & Michigan Southern; J. W. Nesbitt, late of Kentucky Central; N. E. Chapman, Cleveland & Pittsburgh.

Resistance of Trains on Straight and Curved Tracks and on Wide and Narrow Gauge Roads and of Four or Six-wheel Trucks with Long and Short-wheel Bases—W. A. Robinson, Great Western; W. Jackson, Rome, Watertown & Ogdensburgh; C. T. Ham, late of New York Central.

Efficiency of Check or Safety Chains on Engines, Tender, and Car Trucks in Lessening the Danger Resulting from Running Off the Track—R. Wells, Jeffersonville, Madison & Indianapolis; C. R. Peddle, St. Louis, Vandalia & Terre Haute: J. L. White, Evansville & Crawfordsville.

Machinery for Removing Snow from the Track—S. M. Philbrick, Leavenworth, Lawrence & Galveston; J. M. Foss, Vermont Central; E. Studley, late of the Concord.

Machinery and Appliances for Supplying Fuel and Water to Locomotives—H. L. Leech, Boston Locomotive Works; W. Eddy, Boston & Albany; E. Garfield, Hartford, Providence & Fishkill.

Machinery and Appliances for Removing Wrecks and Erecting Bridges—M. Sellers of Pittsburgh; D. O. Shaver, Pennsylvania; S. Moore, Pittsburgh, Fort Wayne & Chicago.

The Best Form and Proportion of Axles for Cars and Locomotives, also whether there is anything to be Gained by the Use of Compound Axles and Loose Wheels—M. N. Forney, Railroad Gazette, New York; C. Sellars, Philadelphia; G. H. Nott, Boston.

THE PRESIDENT—We have also several Committees that continue over, but I think it will be unnecessary to read the list. We have also a recommendation from the Correspondence Committee that a quantity of correspondence be read. Is it your pleasure to have it read now?

Mr. HAYES, Illinois Central Railroad—I move that those papers be laid aside, and if we have time that they be read, but not at present.

Carried.

THE PRESIDENT—There is no report this year on Narrow and Broad Gauge Roads. The Committee consists of Mr. Burke, Memphis & Charleston Railroad; Mr. Waugh, Kansas & Pacific Railway; Mr. Philbrick, Maine Central Railroad. I have had a letter from Mr. Waugh saying it would be impossible to make a report this year. The next report in order will be on the Comparative Performance and Cost of Operation of Eight and Ten-wheel Engines for Freight Service.

Mr. HAYES, Illinois Central Railroad—I believe the report on Incrustation was postponed until to-day, because there was not time to take it up yesterday. Is not that the next in order?

THE PRESIDENT—The report on Incrustation is in order.

The report of Committee on Incrustation was then taken up and read.

REPORT ON BOILER INCRUSTATION.

HANNIBAL, Mo., May, 1872.

To the American Railway Master Mechanics' Association:

GENTLEMEN—The Committee, to whom it was your pleasure to again refer the subject of Boiler Incrustations, their Causes and Cure, would respectfully report that they have given the matter as serious a consideration as the time and its great difficulties would permit.

In accordance with former practice, circulars of inquiry have been addressed for information to various parties, but to such only as might have something to offer, from investigations made since our last annual meeting. We regret that no new or important information has been elicited, throwing additional light upon the subject; your Committee being therefor unable to present any new facts, will have to confine itself to an allusion to the experiments which have

been going on for the past two years, and also to speculation upon the relative cost of purifying water before it is taken into the boiler, if, indeed, such a thing can be accomplished at all. In justice to Mr. J. H. Setchel, who has written at considerable length on the subject, the Committee would suggest that his communication be read in full.

The use of pure water is universally recommended as being the only effectual remedy. Some, however, are still experimenting with fluids, powders, batteries, etc. It will be remembered that the plan, or a similar one, recommended last year by Mr. S. J. Hayes, of the Illinois Central Railroad, was indorsed by the Committee, and embodied in their report as the fundamental principle through which this great evil can only be effectually overcome. It is the opinion of your Committee that the impurities contained in water will precipitate sufficiently for practical purposes after a certain amount of boiling, but whether this method of purifying can be made practicable and cheap is a question which we can not from our own experience determine. We are not prepared to believe that chemical means alone can be economically employed for the precipitation of the materials in water which form incrustations; but to this we shall again refer. A subject which has so long baffled the skill of the leading scientific and practieal minds at home and abroad, can not be properly treated without reaching in vain after the necessary data to make the article wholly reliable and conclusive. We think so great an evil as boiler incrustations, involving in its range violent explosions, loss of life, and great destruction of property, should have the combined effort of scientific and practical men towards the development of a remedy; and to this your Committee, fully realizing the extreme difficulties of the subject, have invited the co-operation of eminent chemists and scientists, and from them they have not as yet obtained anything sufficiently definite to warrant its presentation, and hence they feel that the only way left open to them by which they can discharge their duty to themselves and the Association, who have honored them by their appointment for this particular office, is to present their own crude and imperfect ideas and experience for what they may be worth. It was thought that enough was said upon this subject last year to stimulate an interest on the part of railway

companies in the matter of purifying water before using it in their engines, but we have failed to hear of any experiments in that direction.

Your Committee do not believe a remedy can be devised without more or less experimenting, all of which must necessarily be attended with considerable expense; but they will endeavor to show that at least some economy may be the result.

The plan which we shall attempt to explain is one which we believe will nearly if not quite purify the water before it is taken into the boiler, and it is yet hoped, by the introduction of chemical agents, that this method may be simplified and prove practicable and cheap. Not having tried any experiments in this direction ourselves, we shall be confined to the experience of others to prove our theory, and will first refer to a paper prepared as a report of experiments made by Professor C. F. Chandler, of Columbia College, New York, to the President and Directors of the New York Central Railroad Company upon the various kinds of water used by the locomotives of that Company along the line of that road, with an analysis of the waters, showing their composition, and also an analysis of the scale formation from such waters, and what chemical agents and processes would decompose and prevent the same. The report was read before the American Institute Polytechnic Association, January 11, 1866.

The following article appears in this report: "Boiling expels the free carbonic acid and causes the separation of the carbonates of lime and magnesia, and if conducted at a high temperature, under considerable pressure, results in the almost complete precipitation of the sulphate of lime. This would, however, merely transfer the incrustations from the locomotive boiler to some other vessel and would, therefore, be valueless in this case." This is just what we desire to do, transfer the incrustation from the locomotive boiler to some other vessel provided to receive it and so arranged that the sediment may be removed at pleasure. Then supervenes a difficulty in the use of chemicals for precipitating the lime, etc., from the water which seems to offer two insuperable objections. The first found is in the nature of the chemicals used; for, whilst precipitating the matter forming incrustations, they may corrode the metal itself. All chemicals would have to be used to purify the water be-

fore entering the boiler, in order to avoid this corrosion and also the precipitation into it, which would still demand cleansing of the foreign matter. Then a second objection arises out of the wide differences of water in the different sections; whilst incrustations are formed from those which contain lime, yet there may be and is such a difference of chemical admixtures as to render it wholly impossible to find any one universal chemical sufficient to dissolve these different elements. Hence we feel the necessity of looking somewhere else than to chemical solvents alone for a solution of the difficulty.

If Professor Chandlers's theory be correct, an apparatus can be easily arranged at each water tank along the line of the road by which the water may be heated, and if desired subjected to a pressure, before being taken into the locomotive boilers. From his statement we may assume that the impurities in water will precipitate at a temperature of two hundred and twelve degrees; if this be true, the best and cheapest method of heating the water to this temperature, and its treatment after being so heated, only remain to be proven, and your Committee would suggest the following plan: Let each watering station on the line of the road be provided with a pumping engine or steam pump, with a capacity in proportion to the amount of water required. The exhaust steam from the pump should be conducted into a suitable heater, together with as much live steam as may be necessary to raise the water to a boiling heat. The heater being closed, the water within it at the boiling point would be subjected to a pressure of about fifteen pounds to the square inch. The heater should be made of iron, and as large perhaps as one-third the capacity of the tub. While the heater is being filled the water should be raised to the boiling point, after which the calcarious and other matter in suspension should be allowed time to settle, when the water can be drawn off into the tub arranged to receive it. After the heater is emptied the sediment may be blown off, and this process repeated until the tub is filled, thus keeping up the supply of purified water according to the demand.

The expense attending this apparatus would be equal to the cost of a No. 4 Knowles steam boiler and pumps complete—$450—together with the heater and its fixtures all told would not exceed $1.000; and deducting from this amount the value of the present machinery

employed, consisting of one ordinary horse power and a four-inch hand or power pump, would make actual expense of first cost at such watering station about $800. The second cost, or continual expense, may be estimated in proportion to the amount of fuel consumed for the purpose of heating the water. Assuming as a basis that one pound of coal will evaporate eight pounds, or one gallon of water, we would only have to estimate the amount of coal consumed to arrive at the approximate consumption of water. It has been proven by experiment that if five and a half pounds of water, at a temperature of thirty-two degrees, be placed in a vessel communicating with another one in which water is kept constantly boiling at the temperature of two hundred and twelve degrees, until the former reaches the temperature of the latter quantity and is then weighed, it will be found to weigh six and one-half pounds, showing that one pound of water has been received in the form of steam, through the communication, and reconverted into water by the lower temperature in the other vessel. Now this pound of water received in the form of steam had, when in that form, a temperature of 212°. It is now converted into the liquid, and still retains the same temperature of 212°, but it has raised five and one-half pounds of water from this temperature of 32° to 212°, and this without losing any temperature of itself. It follows, then, that in returning to the liquid state it has parted with five and one-half times the number of degrees of temperature between 32° and 212°, which is equal to 180° and $180° \times 5\frac{1}{2}° = 990°$. Now this heat was combined with the steam, but as it is not sensible to a thermometer it is called latent heat. It is shown, then, that a pound of steam in passing from a liquid at 212° to steam at 212° receives as much heat as would be sufficient to raise it through 990 thermometic degrees, if that heat, instead of becoming latent heat, had been sensible, and $990° + 212° = 1{,}202°$, being the whole amount of heat in steam. Hence it will be seen that one pound of coal, capable of evaporating eight pounds of water, will raise to the boiling point about five and one-half times as much, say forty-four pounds, or five and one-half gallons of water. To this must be added the relative value of the exhaust steam from the pumping engine, which will be equal to five and one-half times the amount of water evaporated in pounds. Supposing, for example, that one locomotive running 2,600

miles a month, or 31,200 miles a year, will make 45 miles to one ton of coal; it would then consume 693 tons of coal per year, at \$2.50= \$1,732.50. If this locomotive will evaporate six pounds of water to one pound of coal, it will require 8,316.000 pounds, or 1,039,500 gallons of water. It is estimated that a No. 4 Knowles steam pump will raise 5,940 gallons of water an hour. In doing this work it will consume about sixty pounds of coal, requiring 10,500 pounds to pump the whole amount of water. If the pumping engine will evaporate eight pounds of water to one pound of coal, the exhaust steam will boil about five and one-half times this amount, or forty-four pounds of water to one pound of coal, equal to 10,500×44=462,000÷8= 57,750 gallons. This would leave 981,750 gallons to be boiled by the use of live steam from the boiler, which will require one pound of coal to five and one-half gallons of water, or 981,750÷5½=178,500 pounds coal ÷2,000=89 $\frac{25}{100}$ tons. This, added to the amount of coal required to pump the water, would make about 94$\frac{50}{100}$ tons, at \$2.50=\$236.25, total expense for fuel in purifying the water in one engine for one year. Boiler repairs, including machinests' labor in taking down and setting up machinery that would not be otherwise done, would amount to about \$550 a year. Of this amount fully sixty-five per cent. may be due to incrustations alone. Judging from reports received by your Committee from Eastern and Southern roads using water, from which no incrustations form, where boilers run from fifteen to twenty-seven years without repairs, it may be safe to assume that even seventy-five per cent. will be saved by the use of pure water. But granting that only sixty-five per cent. is saved, the actual cost of boiler repairs due to incrustations would then be \$357.50.

We will now consider the extra amount of fuel necessary to heat the water through the increasing formation of incrustations, which we will attempt to illustrate as clearly as possible, from the best information we have been able to gather, from both theory and practice. Dr. Joseph G. Rogers, in a paper on steam boiler waters and incrustation before the American Association for the Advancement of Science, says: "The evil effects of scale are due to the fact that it is relatively a non-conductor of heat. Its conducting power compared to that of iron is as 1 to $\frac{37}{8}$. This known, it is readily appre-

ited that more fuel is required to heat water through scale and on than through iron alone. It has been demonstrated that a scale of an inch thick requires the extra expenditure of fifteen per cent. ore fuel. As the scale thickens the ratio increases. Thus, when is one-fourth of an inch thick, sixty per cent. more is required; one-half inch, one hundred and fifty per cent. and so on. To ise steam to a working pressure of ninety pounds the water must heated to 320° Fahrenheit. This may be done through a one-urth inch iron shell by heating the external surface to about 325°. a one-half inch scale intervenes, the boiler must be heated to 00°, almost a low red heat. The higher the temperature at which on is kept the more rapidly it oxidizes, and at any temperature ove 600° it soon becomes granular and brittle from carbonization conversion into the state of cast iron. Weakness of boilers thus oduced predisposes to sudden explosions and makes expensive re-irs necessary."

On most of Western roads incrustations will form to a thickness of om one-eighth to three-sixteenth of an inch in the course of one ar, and increases at a still greater ratio as long as the engine is ept in service. Thus, after four months' time, there will have accu-ulated in our engines nearly one-sixteenth of an inch of scale. his statement will be verified by a specimen presented for your in-ection, consisting of a piece of two-inch flue taken from an engine the Hannibal & St. Joseph Railroad after three months' service, which is adhering a scale nearly one-sixteenth of an inch thick. Dr. Rogers' theory be correct, after one month's service our en-nes will consume three and one-fourth per cent. more fuel than at st; after two months seven and one-half per cent. and so on, king an average for the year of over twenty per cent. more fuel an they would have consumed if using pure water. This, accord-; to the performance of the best coal-burning engines, making ty-five miles to one ton, will amount to an extra expenditure in l of not less than 138½ tons at $2.50, making $346.25 due to in-stations. This, being added to the expense of repairs due to in-stations, will make $703.75. In addition to this the expense of shing boilers may be counted; as by the use of pure clear water ilers would seldom require washing, and the expense of at least

$1 per week or $52 per year would be saved to every engine, swelling the total to $755.75, or $519.55 more than the cost of purifying the water by this process. From this it will be observed that to boil sufficient water to supply a locomotive for one year, running 31,200 miles, will require the extra expenditure of $236.25 for fuel. Now, if boiling alone will purify the water, there would be a saving of $519.50 to each engine, or $51,950 for one hundred engines. Besides all this the use of pure water will absolutely prevent all manner of explosions, ruptures, and leaks, arising from the effects of incrustations. It will also save a large proportion of the repairs to the machinery, not counted in the above estimate, by always supplying the cylinders with pure dry steam of the best quality, free from loose sediment or grit, which always follows the course of the steam, frequently cutting the valves, pistons, and cylinders, and otherwise damaging the machinery of the engine. The use of water, free from mud and organic substances, will absolutely prevent the evil of foaming, which so frequently almost unfits an engine for usual services, until it can reach its destination and be washed out. This and many other prolific evils arising from the use of impure water would, beyond a doubt, be entirely overcome. The introduction into a boiler of any so-called remedies, be they batteries, powders, fluids, or any other nostrums, can hold no comparison whatever to this one perfect and only reliable remedy. Any experiments towards the providing of pure water for locomotive use is a step in the right direction, and when railway companies are aware of the fact that in the Middle and Western States the expense due to impure water and incrustation would amount to the enormous sum of about $75,000 a year for every hundred locomotives, we think they can afford to give the subject a little consideration with a view to making some practical experiments by which reliable and satisfactory results may be reached. The matter of thoroughly purifying the water at a moderate expense is so extremely difficult, that your Committee are not prepared to suggest any particular plan other than that already recommended, believing that nothing in this direction can be definitely known without more or less experimenting.

Mr. Towne, of the Hannibal & St. Joseph Railroad, has been investigating for the past two years with an apparatus consisting of an

ordinary dome, 25 $\times$ 25 inches, riveted to the top of the boiler in a convenient locality to the pumps of the engine, so that the water supply can pass freely through the check pipes to the top of the dome, where it is discharged and caused to fall upon and ripple over a series of heated plates, circular in shape, provided with a series of ribs or stops on their upper surface to retard the momentum of the water, and arrest the sediment as it passes from one plate to another in its course to the boiler. After passing over these plates the water forces its way through a filter, thence to the boiler through a number of one-inch pipes (as per tracing) through which also steam from the boiler is admitted to the dome, distributing itself around and within the heater, maintaining a constant equilibrium of heat between the apparatus and the boiler. Half of these plates are slightly convex and half concave, causing the water to flow from center to side and side to center alternately, passing through holes or slots in each plate on its way to the filter, and finally to the boiler through said pipes, which extend upwards about five inches, forming on top of the boiler (within the heater) a basin for water and a receptacle for any sediment that might lodge there, whence it could be blown off by means of pipes arranged for the purpose.

The filter was composed of coarse gravel, and soon found to be of no practical use beyond the lodgement of more or less incrustation. The shelves were found to gather from one-sixteenth to three-sixteenths of an inch of incrustation in from six to twelve weeks' time, showing clearly that the principle was correct, but the apparatus entirely too small to arrest all the lime, as the boiler and flues were also found to be thickly coated, especially so directly under the heater where the water had fallen upon the flues scale had formed from one-fourth to three eighths of an inch in thickness. After running this engine about sixteen months without any satisfactory results beyond that already stated, it was taken in for temporary repairs, and the heater re-arranged with a view to getting the greatest possible amount of heating or plate surface within its capacity. The filter was accordingly taken out, and the boiler cut out to the size of the internal diameter of the dome, and an additional number of plates put in, about one and a half inches apart, filling the dome full, making sixteen plates in all—a plate surface of about fifty superfi-

cial feet. In addition to this a circular strip of sheet iron, four feet long, was placed inside the boiler, directly under the heater, its ends being flanged upward about two inches, filling the circle of the boiler, and its sides extending downwards to within a few inches of the bottom of the boiler. This was to prevent the water from the heater coming in contact with the flues, and also to provide a still greater heated plate surface, over which the water must travel before reaching the boiler, making, all told, about eighty-two superficial feet of heating surface. The engine is now running with this apparatus, and although it arrests so much lime and mud that it is found necessary to take out the plates and clean them off occasionally, yet it does not seem to stop all the incrustations, and consequently it is not just the thing. Judging from these experiments, as well as others, we do not believe that any apparatus of this kind can be got on to an engine of sufficient capacity to purify the large amount of water required for a locomotive boiler. We think the same device, or a similar one, arranged at watering stations along the line, on a larger scale, might be made to do the work effectually at less expense perhaps for fuel than the first plan. If not by that alone, the introduction of chemical assistants, at a trifling cost, might have the desired effect. The first plan, however, would seem to be the most feasible. The importance of this subject can not be overrated, since it is known that among the many evils of incrustations none are more potent than the fact of boiler explosions from this cause, and nothing can be surer than pure water as a remedy for this class of explosions. There are cases of explosions of boilers at pressures that, without proof to the contrary, may be taken to be very much below their power to resist pressure, showing very clearly that boilers do explode from causes yet unknown. It is then reasonable to suppose, since the fact is not known, that impure water and incrustations may be the source of this unknown element of destruction. Should it be, however, only one cause of such terrible disasters, one point will have been gained; for a single remedy absolutely known is worth more than all the speculative theories extant, as it may lead to the development of a final cure, and in time boiler explosions, other than those caused by low water and overpressure, will no longer be a mystery.

In conclusion, your Committee feel that they are groping in the dark, and can not conceal from themselves what must be apparent to others that the question is yet an open one, and whether the theory advanced will effect a complete solution of the difficulty yet remains to be proven by actual trial. To this end we would respectfully invite the attention of all interested, and recommend a series (if possible) of exhaustive experiments, without which they are convinced nothing definite in this direction can ever be known.

Respectfully,

H. A. TOWNE, *H. & St. J. R. R.*,
J. JOHANN, *P. R. R. of Mo.*, } *Committee.*
J. M. BOONE, *P. F. W. & C. R. R.*,

In connection with this report the following letter from J. H. Setchel, Little Miami Railroad, was submitted and read:

Mr. SETCHEL ON BOILER INCRUSTATIONS.

H. A. TOWNE, Esq., *Chairman Committee on Boiler Incrustations:*

DEAR SIR—Originally the water on this road was all very hard; but since the introduction of coal as a fuel the necessity for soft water has been so apparent that strenuous efforts have been made to obtain it.

At Cincinnati the water of the Ohio River is used, and but little incrustation is found in boilers using this exclusively; and even after engines have run on other divisions and have become heavily scaled a year or twos' use of this water will in a great measure remove it.

At Columbus the water of the Scioto River is used, and with about like results. Within the two points named, where the water is mostly taken from wells, it is highly impregnated with lime, forming on flues and boilers a hard, flinty scale. On one division, of fifty-seven miles, we have more trouble than on any other part of the road. Here the water is taken from wells and is very hard; and, in running this division, we can take engines upon which we are required to do more or less flue work every few weeks, and by transferring them to the main line we are enabled to run them without difficulty. I can account for this only on the score of the difference in the quality of water used

We do not take out flues for the purpose of cleaning them, b
run them as long as they can be kept tight. Copper flues, in engin
burning wood, will run from 150,000 to 200,000 miles. Iron flue
in engines with coal as a fuel, will average from 50,000 to 80,00
miles. We find that the life of the bottom part of boilers seemingl
varies with the quality of iron used. We sometimes find a new boile
eaten out in spots in the bottom part after running three years. Thi
I attribute, to some extent, to the rough places often left in iron b
using too much sand on the rollers while the iron is in process
manufacturing. In forming sheets into shape this sand that has bee
pressed in the iron often drops out and leaves a thin, rough place i
the sheet, to which the scale adheres and enters on the work of de
struction, and subsequently form the eaten places for which the bo
tom sheets are taken out. I know the destruction of the bottom pa
of boilers is often attributed to scale and vegetable matter held
solution in this part of the boiler; but, when you learn our meth
of cleaning boilers, I think you will agree with me that this c
hardly be the case here. I have tried most all the "sure remedies
for preventing and removing scale that has been in vogue for the la
five or six years without any positive good result. I have used Jol
Bull's scaling powder in boilers that were thickly coated, and ha
found that it will remove scale to a noticeable extent. The engin
would steam better and large quantities of scale and mud would
taken from the wash-out plugs for a while; but, in my experience,
find that at certain seasons of the year our boilers will scale more
less without any artificial means being used. Our freight engines
run one hundred and twenty miles four days in the week. This giv
two lay-over days, and on one of these days the water is let out
the boiler when comparatively cold, and the bottom part of fire-b
is thoroughly cleaned of all mud and scale. A two-inch hand ho
plug is placed at each corner of fire-box that readily admits of t
introduction of rods and hose nozzles for this purpose. In the fro
end, at bottom of flue sheet, is another hand hole plug large enou
to admit of a rod with auger or hook-shaped end. Once every t
weeks this plug is removed and the cylinder part of boiler is th
oughly washed together with the leg of fire-box as before. This p
cess keeps the boiler free from mud, but does not, of course, p

vent the formation of scale. To effect the latter I have tried almost everything. Of the mixtures to put inside for the purpose of removing scale I have found none better than the one before mentioned—"John Bull's." I am now experimenting with Hay's "Galvanic Battery" on three boilers; but it has not yet been in use a sufficient length of time for me to form any opinion as to its merits. I know of nothing that will effectually prevent the formation of lime in boilers. I should think that, where water is used containing sand or vegetable matter in solution, a filter might be useful in arresting such impurities. Some years ago we were a great deal troubled by the filling up of the space between the crown-bar by deposits of mud and scale, but since the practice of giving an inch clearance under the bar has been adopted, and the quality of water been improved, we have little or no trouble from this cause.

Respectfully yours, J. H. SETCHEL,

Master Mechanic Little Miami Railroad.

On motion, it was received.

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—I would suggest the propriety, at this time, of appointing a committee to determine the time and place of holding the next annual meeting, and I would make a motion that a committee of five be appointed by the Chair.

Carried.

The following committee was appointed: Mr. Philbrick, Maine Central Railroad; Mr. Brown, Erie Railway; Mr. Woodcock, Philadelphia, Germantown & Norristown Railroad; Mr. Keeler, Flint & Pere Marquette Railroad; Mr. Flynn, Atlantic & Great Western Railroad.

Mr. JACKSON, Rome, Watertown, & Ogdensburg Railroad—If my recollection serves me right there is no Committee on Mileage and the Wear of Tires. I think that question is a very important one. We want to watch these steel tires from year to year, and it seems to me as though we ought to keep that Committee up. I move that there be a committee appointed upon this subject, so as to keep up the mileage of tires.

Agreed to, and J. N. Lauder, Northern Railroad; E. Studley, late of Concord Railroad Co., and A. Griggs, Worcester & Nashua Railroad, appointed.

DISCUSSION ON BOILER INCRUSTATION.

Mr. COLEMAN SELLERS, of Philadelphia—This subject of incrustation is one of great importance, and one that has interested me for a number of ears. I would state, in regard to the formation of incrustation, that it oc-

curred to me that a microscopic examination of the sediment formed
ers might be of use. With a view to this, I went into an extensive
examinations with the best appliances and with various machines f
cing the sediment to a transparent condition. I investigated the f
of the crystalline deposit and found, in a majority of cases, the same
material seemed to hold with different kinds of deposits. I am sor
that the investigations, extending over a number of years, did not
any practical elucidation of how the trouble might be avoided; bu
ing of the matter, in reference to the possible appliance of some m
to effect the purification of the water, that of boiling it naturally
to me. I am pleased with what the Committee report on the subjec
seems to me they don't take into consideration the element of tim
necessary. The formation of deposits is almost the same as that
as they were originally formed. Those were formed under press
heat, but they had the element of time. The mere heating of wat
pressure does not get rid of these deposits. It would have to remai
preciable length of time, and this length of time would entirely
the possibility of that being used at stations as a means of purif
water. Then, if water could be made entirely pure, it is doubtful wl
is of any use. On the ocean steamers they use distilled water, an
trip it was found that it was so deteriorating the boiler as to be of n
at all. The difficulty was got over by receiving in every day a
quantity of salt water. It may be that pure water is more ready to
substances than water partially saturated with other substances.
that is so I can not say; but it seems to me where pure water has b
there has been a more rapid deterioration than with water impregna
salts or other substances. In the southern part of Illinois a series
riments is being tried which may throw some light on this subject-
of experiments towards getting the lime out of the salt wells. Tl
to separate the lime, and the same experiments may eventually be
this other purpose; and, probably, by the time of another meetin
Association some light may be thrown upon the matter.

Mr. FRY, Grand Trunk Railway—I would call the attention of t
ing to the importance of the remarks made by Mr. Sellers yesterda
ing of the Institute of Technology; and I would propose that the C
be requested to correspond with that Institute and ascertain whethe
sent specimens of water from the West, or specimens of the s
formed, the Institute would experiment upon those waters and tr
us some information. It may be difficult, perhaps, to get the railr
panies to expend large sums of money in employing chemists, but
lers informed us that he thought the Institute would even be glad to
water upon which to experiment, and if so it would be very valual
there being but few of us who are competent ourselves to investiga

tifically, the constituents of water. I propose that the Committee be requested to correspond with the Institute and request them to experiment upon some of our water for us.

THE PRESIDENT—We have no Committee on Incrustation for next year, unless the Committee be first ordered.

Mr. FORNEY, Railroad Gazette—One of these subjects includes the purification of water, which, I presume, would cover the subject of incrustation.

Mr. TOWNE, Hannibal & St. Joseph Railroad—This matter of simply sending samples of water to be chemically tested and proved, to find out what the water contains, is all very well so far as it goes. We know all the water in the West contains more or less of incrustation; more lime probably than anything else; but no two roads have the same formation of incrustation. Most of the roads have more or less lime. Illinois, Wisconsin, Iowa, and Nebraska have more or less of the alkaloid formation. Missouri has some iron; that you all know is a very great mineral State. With water in which there is more or less iron the formation of incrustation is very hard, and very much harder to do away with than that of lime. The formations on the Hannibal & St. Joseph are principally lime and sand incrustations. That comes from the water in the Missouri River, and along its bottom, and is quicksand and lime to a very great extent. The simple matter of having these waters analyzed don't get at the point at all. We want to find out what will prevent this incrustation, and keep our boilers clean. It is said that pure water is injurious to the boiler; that may be so, but I never knew of the fact before. If that is the case, it will be well then to find out what sort of impurities it is necessary to add to pure water, to act in connection with the iron, and prevent this formation or deterioration of the iron by the use of pure water. Until we can get at some theory or practical plan of purifying the water, and preventing this water, that contains these impurities, from getting into the boiler and forming this incrustation, we are bound to have this trouble. As stated in the report, incrustation will form to a thickness of one-sixteenth of an inch in three or four months on our flues. It takes, according to Doctor Rogers' theory, about seven and one-half per cent. more fuel to heat water through this formation, or incrustation after three months, than it did at first; and so on, until finally it makes twenty per cent. more fuel necessary to heat the water through this formation than it would using pure water, or where there is no incrustation. In connection with the lime in the water we have a great deal of mud coming from the surface water. The mud in itself, perhaps, could be got out, or would do little harm; but there seems to be just lime enough in the water to harden this mud and form incrustation. I have samples here showing the effect. This is, perhaps, one-third lime; just enough to make the mud hard and prevent heating the water through the formation. If an analysis of the differant waters of the different roads could be arrived at, there is no single remedy that

could be applied to the different formations. Simply an analysis of the of one locality would not do. We should have to have an analysis different wells along the line of the road. We have one place whe waters contain a large portion of fire clay and sulphur, making a very and solid formation. I have a sample, also, of that. This water through a coal mine. The boilers in that coal mine seldom last more two years at the best. The impurities contained in the water eat th away and destroy it in a very short time. There is really no end to th ject of incrustation. The Committee on this subject have consulted all ner of publications, and I have corresponded with several of the best ch in the country, and have failed, in every instance, to get any satisf solution of the matter of preventing incrustation. We all know that motive boiler is so constructed that it is very difficult, after the incrus is loosened by mechanical means, batteries, or anything of that kind, that incrustation out of the boiler; it is, in fact, impossible; consequen lies there. If you commence to take out a portion of the flues, at the b you find mud. Sometimes they are very nearly half full of mud, packed In some instances, where we have used perforated pipes running throu boilers, a portion may be removed. The steam passing through thes forated pipes will take up as much of that mud as the eddy produced l suction will draw, and, perhaps, take out some, but it will not take it a We stop our engines every six months for the purpose of clearing o boilers; with the exception of this, we make it a practice to clean reg with a force pump, which takes it out very nicely; but that don't p the formation of incrustation. The mud is about as much trouble as i tation. It is a difficult subject to handle. I wish some other com would be appointed on this subject, to give them a chance to take hold and I would like to hear from other members of the Convention in to it.

Mr. Gregg, Erie Railway—Mr. Towne has just suggested that some committee take hold of this subject. I think it would be a great mist have another committee take this subject up, just where our last year' mittee have left off; for the reason that they undoubtedly have give great deal of labor and attention to arrive at the conclusions they hav produce such a report as they have presented here to this Associatio morning. If a new committee on boiler incrustations, or water impu take up this subject, in all probability they will go over a great deal same ground, and arrive at the same conclusions that the former com have; while, if the present committee is continued on the subject the go forward with their labor and secure information that will be very ble to us; and hence, I think, it would be an advantage to this Associat our former committee, that is, last year's committee, were continued o same subject of boiler incrustation; regardless, however, of whatever

mation the committee on water impurities may bring forth. It has been suggested that there is a committee on that subject already; but I do think it will be a great advantage to the Association to have the former committee on this subject continued. They have secured a great deal of valuable information, which a new committee will have to go over the same ground to secure, and we shall be no better off the coming year than we are now. This subject is one of the greatest importance to all railroad companies, and to us as master mechanics, and, if it is consistent, I move that the same committee be appointed on boiler incrustations.

Mr. Fry, Grand Trunk Railway—Before putting the question it may be well for me to explain a little further my object. The same matter that Mr. Towne mentioned occurred to me—the difference in the different waters of the country—and at first I thought of requesting that a sample of each kind of water should be sent. Then I remembered that most of our Western waters produce a sediment, and that our Western men are noted for their energy, and I thought the Institute might be sorry that they corresponded with us, as car load after car load of sediment and hogshead after hogshead of foul water were deposited at their doors, and think that they had corresponded with us to no good purpose. The Institute have paid us the compliment of inviting us to come to see them, evidently recognizing our importance as a practical body of men, and I thought it would be a return of the courtesy for us to acknowledge their scientific acquirements and request them to assist us in matters about which we can not understand a very great deal. They might possibly, by analyzing the water, suggest certain experiments which would not occur to us, and we could try those experiments, and when we get the practical workingmen in the country to work in harmony with the scientific men in our institutions we shall have arrived at a very happy state of affairs. I think it would not be courtesy to allow their invitation to pass without some return of this kind, and if it meets with the spirit of the Convention I hope some little notice of that kind will be taken. I, however, think that a few samples of the waters at different points along our Western lines will be sufficient. Whether another committee is appointed or not I think is a matter of secondary importance.

Mr. Hayes, Illinois Central Railroad—Before the close of this discussion I have a word or two to say upon the subject of incrustation. Some of the gentlemen here have stated that perfectly pure water will destroy a boiler more than water with a moderate amount of solid matter. However that may be I don't know, but I somewhat doubt the truth of the statement. Some years ago, when connected with the Baltimore & Ohio Railroad, we ran engines from Baltimore to Washington; they passed through a country that was very sandy; most of the water came through sand heaps and was supposed to be very pure. With that water we could run for six months and not make a deposit in the boilers as much as we in the West,

going through Illinois and Wisconsin and the adjacent States, will make i one week. We scarcely ever washed out a boiler between Baltimore an Washington more than once in six months. It is a hard matter for us some times to run more than one week without washing out. We all know th when pure running water is used in boilers you may use boilers almost f an indefinite time. It is a question in my mind whether this water that yo distil out of the sea water is perfectly pure. I think you still retain a po tion of the salts in that water. Whether that is correct or not I am n chemist enough to say, but this much I do know: Where we have used pu water out of the mountains on the Baltimore & Ohio Railroad, or from the san hills between Baltimore and Washington, we could run boilers for an indef nite time without any injury, or scale, or formation in the boilers. Out i the Western country the water is principally lime, magnesia, and silic That is the principal portion of the incrustation formed in our boilers. No if we can get something that will take those three articles out of the water w have what we could call comparatively pure water, although chemical speaking it may not be pure, and we could then get along, I have no doub with twenty-five per cent. less of expense in repairs of boilers and I wi say also of machinery, because when an engine is brought in for repairs the boiler, you almost invariably tear down machinery which might run f six months longer if you had pure water in your boilers before it came for repairs. Now, we have used in Chicago on our stationary engines a apparatus patented by a German in our State. It is a very imperfect app ratus, but it is a question in my mind whether it will not lead to som thing which is very valuable to railroad companies. It is simply a tub, fo feet in diameter and six feet high. It is filled with iron promiscuously with pieces of iron of different shapes—and the exhaust steam passes through that iron, and the water is received upon the top and led in sma jets down from that iron as the exhaust steam comes in contact with it pas ing up. In six months we get that thing filled almost solid with those su stances, lime, magnesia, and silica, such as are contained in the water ther and we find that that boiler now, after running two years, has not as mu deposit in it as we would have got in one month with the ordinary proce It is a simple process. Could not something of the kind be got up cheap upon railroads, and be adopted to take this foreign matter out of the wat before we receive it in the boilers? If that can be done (and I see no reas why it may not be) it seems to me some of our chemists, who are better a quainted with the subject than I am, could give us suggestions in regard to that would be valuable. I formed my idea of this arrangement from rea ing the report of Professor Chandler upon the New York Central. He sa it can not be precipitated unless by a certain heat. In this apparatus we g that certain heat. He says if you do it in a separate vessel it is as expe sive to get it out of that vessel as to get it out of the boiler. It is no expen

at all to get it out of this apparatus I speak of. All you have to do is, when the engine stops, to take out these pieces of iron and throw them into the fire and put in another set. The fire will take this deposit off, consequently you have to have two sets to throw into the vessel, and in this way you get all or nearly all the solid deposit out of the water. It was from reading that report that the thing was brought to my mind, and the idea suggested of making this experiment, although the original idea is from this German, in Champaign County, in our State. After reading this report, it struck me it would be a good thing to see if we could not use it upon railroads. We use it on the stationary engine, and have used it for three years, and it is doing good service; preventing, I might say, almost all incrustation in that boiler. It uses but two and a half tons of coal, where, when the boiler was full of this incrustation, it took nearly double that quantity of coal to run the same machinery. It seems to me if it could be brought before the minds of railroad presidents and superintendents to appropriate a certain sum to go into these experiments there might be some good results grow out of it.

Mr. GREGG, Erie Railway—I have been interested in this matter of incrustation, having had considerable experience with that trouble. I don't want to hold this Convention with a long talk on this subject, but I would move that a vote of thanks be extended to our Committee on Incrustation whose report we have just heard—very lengthy and exhaustive indeed—and that they be requested to continue for the coming year.

THE PRESIDENT—A committee has already been appointed upon that subject of which Mr. Towne is the Chairman. The other members have been changed. The committees are all arranged, and we have tried to arrange them so that there shall be no one member upon two committees, and to pass that motion will disarrange the committees.

Mr. GREGG, Erie Railway—My whole interest was concentrated in Mr. Towne, and I will withdraw the motion.

The vote of thanks was then passed.

THE SECRETARY—I wish merely to say that on the road I represent we are very much troubled with incrustation, and without making any further remarks I will show you some specimens. That is what we get out of our boilers after five or six years' service. Get the right light on it and it fairly glistens; looks as though it was covered with diamonds. Here is some other scale that came from boilers using the Ohio River water exclusively. This piece came off from the flues, four or five feet from the front flue-sheet. We take a great deal of pains with our boilers, never running a boiler over one week without washing it out. We have hand-hole plates in the bottom of the fire-box, and once a week they are taken out and water run through, and great care taken to get out all the mud and sediment that may be collected. Then, the next week, there is a plug put for that purpose in the front flue-sheet, and and that is taken out, and the barrel of the boiler washed out with

rods, and every care taken to prevent the formation of mud and sc
yet these deposits form sometimes very quickly. These, however, we
from a boiler that had been in use six years since the flues were t
Here is another specimen taken off from the side of the fire-box. I
on our road we have tried almost everything that anybody desired to h
for the purpose of preventing the formation of scale, and latterly
been trying Mr. Hay's battery, and there is a piece of a flue taken
engine where the battery had been in use nine months. I confess I
much disappointed. I had formed the opinion it would almost enti
vent incrustation; but on taking this flue out the incrustation, whi
pected, if there was any formed it would be rotten, but it seemed firm
than on other engines and entirely covered. You see it is about on
second of an inch thick. That was formed in nine months. Here i
specimen of a scale. I had a flue taken out of a boiler that had been
teen months, and you see that it is hardly as thick again, and the ap
of the scale on the flue was very different from the appearance of t
Instead of its being firm and solid, in some places there was no scale
the flue; it was pitted all over, but the scale on these flues seemed t
ging perfectly tight; not a spot but it was covered. I am utterly
account for it. Mr. Jauriet has written a communication to the Co
speaking very favorably of it indeed. He thinks it will be a pe
cess, and that it will not only remove scale but will prevent explo
think, perhaps, the subject is worthy of attention. The gentleman
this on tells me he takes the blame to himself. He says he thinks h
apply it right and did not attend to it properly. However, he
whole matter in his charge, and if he did not we are not to blam
That is the result.

Mr. Towne, Hannibal & St. Joseph Railroad—In connection wit
ing samples of incrustation I would like to present this for the bene
Association, especially to the Eastern members who have no trouble
pure water. There is a formation principally from the water in the
River, not directly from the river, however, but that which percolate
the sands of the Missouri bottom. Our shops at Kansas City are lo
haps half a mile from the river. We use there what is called a "dri
or pipe well, to fill the tank. All the water for the engines there at
is supplied from this drive well. The water comes up with a gre
quicksand, and this formation appears to be quicksand and lime. It
two inches thick, having the form of the flue on one side. It formed
the outside flue and the shell of the boiler, about four rows from th
a place where we could not get at it to wash it out; and hence the fo
The boiler was washed once a week, sometimes twice a week; yet thi
tion grew up there in seventeen months' time. It was like that al
entire length of the flue, from that to this thickness: that is three-
and that is two inches. The flues all through the boiler were mor

coated. Some of them, where they were nearly half an inch to five-eighths of an inch apart, were nearly welded together by this formation. That was one engine; other engines troubled us the same way. Here is a formation of a different character taken from a stationary boiler in our shops at Hannibal. This was formed round three flues, welding them close together. We used the Silliman filter, which is one of the best we have to prevent formation; but the one we have is not large enough. A good deal of this stuff gets through. The water is thoroughly heated, falls down on the filter and passes through without having time to settle. The result is, the mud and lime and impurities of the water pass on to the boiler and form this incrustation. I find in my experiments, and we all I think have discovered it, that it is quite as necessary to keep the mud out of the boiler as it is to do so with the mineral substances contained in the water. In reference to the Hays' battery, it may prevent the formation of lime, but it certainly will not keep the mud out of the boiler. If it will crack off the lime, it may do very well for a boiler that has the formation already on; it may break off the incrustation, and you can wash out a portion of it, but not all. We tried two of those batteries on the Hannibal & St. Joseph Road. We had one of them on nearly a year and one nearly eighteen months. I could not discover any beneficial results from the use of it. Perhaps we did not try it as we should have done. It was among the first that was used. We have never seen Mr. Hays at all, and don't know but he can put one on that will answer the purpose. If he can, I wish he would do so. To get any good results at all from the use of fuel, we find it necessary to wash out very often and take out the bottom rows of flues—twelve to twenty flues—and give it a thorough cleaning. Our road is not any worse, perhaps, than the Illinois Central or the Chicago, Burlington & Quincy Railroad. The roads on the line of the Missouri River realize the same difficulty—the Missouri Pacific, the Kansas City, St. Joseph & Council Bluffs, and all other roads. In that report we refer to an apparatus I have been using for the last three years, nearly, for the purpose of purifying the water and extracting the lime and other impurities, and keeping them from getting into the boiler. I have here a model of the apparatus that I use. While it answers very well, so far as it goes, it does not do the work altogether, and therefore I contend it is not the thing. Neither do I believe you can get anything on a locomotive that will do it. This is a dome twenty-five inches in diameter by thirty inches high. It is filled full of plates an inch and a half apart. The water is conducted into the sides through the check valves. The water is fed through a pipe in the center up to the top of the dome with considerable force, strikes the top of the dome, or dome cap, which adds to the heating surface somewhat, and by the time the water falls upon the first plate it is nearly boiling hot. I find that to be the case by testing it with a gauge or thermometer. There are sixteen of these plates. The water falls from the top of the pipe on to this plate, passing from this plate on to the second one, rippling along

down until it falls down here. By this means I think, perhaps, if the plates were sufficiently hot, we might stop this incrustation by gathering it up on these plates, and it does do it to a great extent. These plates we take out once in six weeks and clean them off. Sometimes there is one-quarter of an inch of scale, and with all that we find it in the boiler and on the flue. I brought this simply to show, though I suppose it is as good a thing as there is in use; that is, I have not heard of anything that is better—that it is not the thing altogether, and I don't know of anything that you can get on to a locomotive that will purify the water. I understand that Mr. Congdon, of the Union Pacific, has used a similar apparatus, but instead of having these plates (this dome is on the forward part of the boiler over the check valve) he simply uses a basin instead of the dome, to which he conveys the water, and the water rises and flows over the top. He claims that will purify the water. I also understand that another gentleman on some road in Illinois is using substantially the same thing—Mr. Jackman—I don't know whether he is present or not. If so, I would like to hear from him. He also claims that that will purify the water. Those two gentlemen are both using the same thing or about the same thing, as near as I can learn. I have been using this for three years, and you have heard the result.

Mr. GORMAN, Toledo, Wabash & Western Railway—It may not be out of place here to mention a little case that came under my own observation in regard to purifying water. In 1864 I went down into Arkansas. They were building a road called the Mississippi and Ouochita Road, and they had but one engine and did not have any water tank to take water from, and consequently they stood on a bridge at a bayou and pumped the water as it was required. That bayou was fed from the Mississippi River. I did not like the place and did not calculate to stay. I asked the foreman how long he had been there. My business was to run the engine and be chief cook generally I asked the engineer how long the boiler had been running, and he said two years; he had been there all the time. "When was it cleaned out?" I asked. "Not for a year and a half." "My gracious!" said I, "the thing must be chuck full of mud. This will not do if I stay here; I don't propose to let them burn the boiler up." I went to the superintendent and told him if the water was anything like what I was in the habit of using the boiler must be full of mud and I would clean it out if he would allow me to stop on Saturday. I expected to have a big job; that I should have to punch the hand-hole plates in and dig mud generally. I took the engine and blew her off, got a pinch bar and got underneath and punched in the hand-hole plate. The hand-hole plate went right into the boiler. That astonished me. I reached in, and there was not as much mud in that boiler as you could hold in your hand, and not a particle of scale. The color of the iron was changed somewhat inside. It looked like the browning on a gun barrel. I put in the hand-hole plate, filled up the boiler and fired her up, and went up along this

water was very dirty and had a very offensive smell. The was filled up with all kinds of vegetable matter—trees, shrubs, nd things of that kind. I had never seen anything like it before. e on my way back to Memphis I stopped to see Mr. Yager (I s his name), the Master Mechanic of the Memphis & Charleston anxious to find out what it was that kept that boiler in condition, im if anything of that kind ever came under his observation. He he had a little bayou and all he did when his engines got foul hem there to use that water and it cleaned the boilers out. That ned nothing but the vegetable acid that was in it. If any of the ow what was in it I would like to find out.

ON, Rogers' Locomotive Works—I think this subject is a very e; otherwise I should hesitate to say anything (we have already ll ventilated) on the subject of preventing this deposit of scale. experience on a road where we used to be troubled with ex- sits of lime, and we had a water station at one place on the road ater was taken from a swamp, and when the boilers became foul ive them a pretty large dose of this water, and it invariably re- bling us to wash out this deposit that would have otherwise been a short time. What the particular material was that produced this t know. I suppose it was vegetable matter of some kind or other. e also we used to be in the habit of putting in occasionally, when out the boilers, at times when we could not get sufficient of this nut bark, or something of that kind, which enabled us to get rid osits without their forming hard scales. I apprehend the solu- question will depend upon the best method of preventing the ard scale. What we want to do is to prevent the deposit of hard e can do that before we put it in the boiler, so much the better, do it cheaper by some apparatus on the boiler that will be an I am impressed with the efficiency of something of the kind een illustrated by Mr. Towne. I think that or a similar appa- ed on some of the German railways some years ago. I am not from recollection how long ago, but my memory is very distinct ead of an apparatus of that character placed upon the dome and th pans very much after the manner described by Mr. Towne. I ose he is aware of it. I was very much impressed at the time sibility of allowing the earth and sediment to deposit in those could be removed by cleaning them; and I think, if I recollect oad having this apparatus in use, was in the habit of doing that , or as often as might become necessary. As I said before, I am bly impressed with that method of getting rid of the sediment. all know that the greatest deposit of sediment, especially among kes place where the water is introduced; and if we can allow that

matter to settle before we introduce it into the boiler, where it can be periodically taken out, we shall get rid of very much of the difficulty. There is another subject, however, in connection with pure water. I believe I stated yesterday, that pure water, I was afraid, would fail to accomplish the result. I have no doubt upon that subject. I do know from some little experience in this matter that it will affect the metals of the boiler, rapidly eating them up, dissolving them, I suppose, chemically. There is another fact in connection with pure water. However, I don't anticipate any trouble from that. It is that it may be heated beyond the point at which ordinary water gives out steam, without giving out much steam, and then may suddenly give out the heat which is accumulated in it in a state of partial explosion. Whether any evil would result from that I am not prepared to say, although I think it would be very undesirable.

Mr. Robinson, Great Western Railway—Nothing has been said about the metals used in boilers; how far they affect the sediment on those metals. We know that brass tubes do not gather sediment so quickly as iron. I think steel-fire boxes don't gather it so quick as copper fire-boxes. I would like to ask this Convention whether there is any one here who has tried steel fire-boxes of a thin construction. My impression is the thinner we can use our material with safety, the better it will be for the accumulation of steam. My experience with tubes has been this: We have always used copper or brass until lately, when we have used iron; and we find in running boilers nine to twelve months, we get three times as much scale as on brass or copper tubes, necessitating the removal of a large number of tubes. For that reason we have abandoned iron and gone back to brass again. We can run four or five years without removing tubes, and in that time not get as much sediment as would be gathered on iron in one-fourth of the time. I would like to know if anybody has tried steel tubes. What we want to gather at this meeting is the experience of others from which we can save expensive experiments ourselves.

Mr. Boon, Pittsburgh, Fort Wayne & Chicago Railway—On our line we have steel, iron, copper, and brass tubes; also, steel, iron, and copper fire-boxes, and we never could discover any difference in the amount of sediment. The amount is about the same. The amount on the iron would be a very little more, but it is so little as to be scarcely perceptible.

The report of the Committee on the "Comparative Performance and Cost of Operation of Eight and Ten-wheel Engines for Freight Service," also report of Committee on "Comparative Performance and Cost of Operation of Ten-wheel Engines, with Six Drivers Coupled, and Eight-wheel Engines with Four Drivers Coupled," were read.

REPORT ON COMPARATIVE PERFORMANCE AND COST OF TEN-WHEEL ENGINES WITH SIX DRIVERS AND EIGHT WHEEL ENGINES WITH FOUR DRIVERS COUPLED.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, appointed at your last annual Convention on the relative merits of the three classes of freight engines, viz.:

The six-driver engine with two-wheel truck; the six-driver engine with four-wheel truck, and the four-driver engine with four-wheel truck, beg leave to submit the following:

We have received answers to our circular from twelve master mechanics; the most of them expressing no opinion in regard to the merits of the different engines. Two are in favor of the four-driver four-wheel truck engine for roads with grades of seventy feet to the mile and under; but for very heavy grades and slow speed they would prefer the ten-wheel engine. As there were so few answers to their circular the Committee ask your attention to the experience of the New York Central Railroad.

They have twelve "mogul" or six-driver and two-wheel truck engines and three ten-wheel engines. Each class of engines (eight and ten-wheelers) have been in all kinds of service except passenger, and the most of the "mogul" engines are two years old. For all kinds of freight service they prefer the "mogul" at a speed of twenty miles per hour and under, and give as a reason that the "mogul" is easier on the track and not as hard on a curve as the four driver engines. We also inclose with this miles run, cost in cents for repairs, weight of engine, and comparative power of the "mogul" and four-driver engines of the New York Central Railroad.

In the summer of 1870 the road was hard pushed for power on the Western Division, and two of the "mogul" engines were sent to help them out. They remained three months, and during that time hauled double the cars the 16×24 inch four-driver engines did. On the Rochester and Niagara Falls Division twenty-five cars is a full load for a 16×24 inch cylinder four-driver engine. Drivers being

five feet in diameter, weight of engine thirty-one tons. The "mogul" engine No. 95, cylinder 18×22 inches, drivers fifty-seven inches in diameter, hauled fifty cars each way on that same Division for three months, and did not lose a trip during the entire time ("Mogul" engine, 18×22 inch cylinder, fifty cars; four-driver 16×24 inch cylinder, four-wheel truck engine, twenty-five cars.)

The New York Central Road also has six "mogul" engines 15×22 inch cylinder, drivers fifty-seven inches in diameter, gross weight fifty-eight thousand pounds, which are hauling the same number of cars as the four-driver, five feet in diameter, four-wheel truck, gross weight sixty-four thousand pounds—both engines having the same pressure of steam.

The Chairman of your Committee is of the opinion, with the experience he has had with the "mogul" engine, that the freighting on the New York Central Road can be done for thirty-five per cent. less with a "mogul" engine, 18×22 inch cylinder, weight of engine seventy-five thousand pounds, than with a four-driver engine, 16×24 inch cylinder, four-wheel truck, weight of engine sixty-four thousand pounds, for the following reasons:

1. The "mogul" engine is carrying seventy-five per cent. less dead weight on truck than any other class of engines that use a truck.

2. The weight is better distributed than it can be with any other build of engines.

3. They are much lighter on the rail than any other class of engines of the same weight.

4. They will haul thirty-three per cent. more cars than a four driver engine—the cylinder, drivers, and gross weight being the same.

5th. They are about two thousand pounds lighter on each pair of drivers than a four-driver engine four-wheel truck both engines being the same gross weight.

In conclusion, he believes the "mogul" engine the best adapted to all kinds of freight service of any class of engines now in use, and your Committee fully agree with him.

COMPARATIVE STATEMENT

mogul six-wheel, two-wheel truck; six-wheel, four-wheel truck, and four-wheel, four-wheel truck engines, New York Central and Hudson River Railroad.

No. of Drivers.	Size of Cylinder.	Mileage...........	Average cost per mile for repairs, in cents..........	Gross Weight...	Cars Hauled....	Remarks.
	Inches.					
6	15×22	43,600	.93	58,000	35	Mogul engine.
6	15×22	43,500	1.34	58,000	35	" "
6	15×22	53,600	1.11	58,000	35	" "
6	15×22	24,335	2.00	58,000	35	" "
6	15×22	43,600	1.00	58,000	35	" "
6	15×22	42,560	.99	58,000	35	" "
6	18×22	54,515	2.04	75,000	50	" "
6	18×22	58,225	1.45	75,000	50	" "
6	18×22	58,070	1.61	75,000	50	" "
6	20×20	44,175	1.21	75,000	50	" "
6	18×22	35,000	.88	75,000	50	" "
6	18×22	26,914	5.07	75,000	50	" "
6	17×20	20,969	7.33	77,000	40	
6	17×22	39,900	5.36	77,000	40	
6	17×22	25,549	2.26	77,000	40	
4	16×24	38,400	8.44	64,000	38	
4	16×24	41,355	4.10	64,000	38	
4	16×24	32,996	3.22	64,000	38	
4	16×24	43,300	3.51	64,000	38	
4	16×24	34,067	5.41	64,000	38	
4	16×24	48,349	4.85	64,000	38	
4	16×24	36,223	4.59	64,000	38	
4	16×24	40,320	3.78	64,000	38	
4	16×24	38,919	3.82	64,000	38	
4	16×24	49,696	4.12	64,000	38	
4	16×24	39,734	3.19	64,000	38	
4	16×24	39,074	3.25	64,000	38	

verage mileage, mogul engines, 15×22 inch cylinders, 41,866, at cost for repairs, 1.23.
" " " " 18×22 " " 46,150 " " 2.04.
" " 10-wheel " 17×22 " " 28,806 " " 4.98.
" " 4-driver " 16×24 " " 40,203 " " 4.35.

DIMENSIONS OF ENGINES.

gul—15×22 inch cylinder; diameter of drivers 47 in.; 135 iron flues 10 ft. 6 in. long, 2 iameter; fire-box 50 in. long, 60 in. deep; boiler 44 in. diameter.
gul—18×22 inch cylinder; diameter of drivers 47 in.; 146 iron flues 11 ft. 6 in. long, 2 iameter; fire-box 65 in. long, 60 in. deep; boiler 46 in. diameter.
.wheel—Boiler 46 in. diameter; 145 iron flues 12 ft. long, 2 in. diameter; fire-box 60 ng, 60 in. deep.
ur driver—16×24 inch cylinder; boiler 46 in. diameter; 145 iron flues 11 ft. 6 in. long, diameter; fire-box 60 in. long, 60 in. deep.
leage is for year ending September 30, 1871.

COMPARATIVE STATEMENT

Showing difference in our mogul engines, 6 driver, 57 in. di two-wheel truck, 18×22 *in. cylinder,* 46 *in. diameter of boil flues* 11 *ft.* 6 *in. long,* 2 *in. diameter, fire-box* 65 *in. long, deep, and a 4-driver engine,* 68 *in. diameter, 4-wheel truck, in. cylinder,* 46 *in. diameter of boiler,* 145 *flues* 11 *ft.* 6 *in. in. diameter, fire-box* 60 *in. long,* 63 *in. deep.*

"Mogul," Two-wheel Truck.	Po
Weight of engine with two gauges of water	7
" on truck	1
" " " and first pair of drivers	3
" " " " " and second pair of drivers	5
" " first pair of back drivers	1
" " " and second pair of back drivers	3
" " three pair of drivers	6
" of water in boiler (698 gallons)	
" " empty engine	6
" " tender with 2½ tons of coal	4
" " water in tank (2,000 gallons)	1
" " coal	
" " water and coal	2
" " empty tender	1

Four Driver, Four-wheel Truck.	Pc
Weight of engine with two ganges of water	6
" on truck	2
" " " and main drivers	4
" " back drivers	2
" " both pair of drivers	4
" of water in engine	
" " empty engine	6

DIFFERENCE OF WEIGHT OF ENGINES AND ON DRIVERS.

"Mogul" full weight .... 75,300 lbs. On Drivers ....
"Four driver" full weight .... 65,970 " " " ....

Difference .... 9,330 lbs.

Adhesive Power—"Mogul" (600 pounds per ton of weight on drivers) or $\frac{64,820\times600}{2,240}=17,362$ pounds.

Adhesive Power—"Four driver" $\frac{41,700\times600}{2,240}=11,170$ pounds.

Difference in favor of "Mogul" 6,192 pounds. 55.4 per cent. more adhesive po

Power of "Mogul" in Horse Power—Running speed of engine twenty miles Steam pressure in boiler 125 lbs. per square inch. Maximum pressure in cylin per square inch. 125 revolutions per minute for 20 miles per hour. Area of p square inches. $\frac{254.4\times60\times44\times125\times2}{33,000\times12}=424$ horse power.

POWER OF "FOUR DRIVER" ENGINE IN HORSE POWER—Running speed of engine twenty miles per hour. Steam pressure in boiler 125 lbs. per square inch. Maximum pressure in cylinder 60 lbs. per square inch. 100 revolutions per minute for 20 miles per hour. Area of piston 201 square inches. $\frac{201 \times 60 \times 48 \times 100 \times 2}{33,000 \times 12} = 292.36$ horse power.

Difference in power, 131.64 horse power. 45 per cent. more in horse power "Mogul" has over "Four driver." For each engine working the same number of revolutions per minute (125 revolutions) the difference in horse power would be 16.33 per cent.

LETTER FROM MR. HILL, OF THE ERIE RAILWAY.

NEW YORK, May 9, 1872.

C. T. HAM, *of the Committee on "Comparative Cost and Performance of Engines, etc.:"*

In regard to the comparative merits of the eight-wheel engine with six drivers connected, and ten-wheel engine with six drivers connected, I would say:

We have only a few of the latter class of engines, and they are all very old, and we are gradually wiping them out. In my opinion there is no comparison between these two classes. I believe the "mogul" to be the best engine for all kinds of freight service—far superior to the ten-wheel engine, or the ordinary eight-wheel engine with four-wheel truck—if it is properly constructed.

I think Mr. Brown, our Master Mechanic at Jersey City, has given you a report on this subject, so that anything I might say would be only a repetition.

Very truly yours,

E. O. HILL.

REPORT ON COMPARATIVE PERFORMANCE AND COST OF OPERATION OF EIGHT AND TEN WHEELED LOCOMOTIVES.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, appointed at the last meeting at Louisville, Kentucky, September 14, 1871, on the "Comparative Performance and Cost of Operation of Eight and Ten-wheeled Locomotives," beg leave to submit the following report:

We have received replies to the printed circular of questions from sixteen railroads, as follows:

C. F. Jauriet, Master Mechanic Chicago, Burlington & Quincy Railroad: Have one hundred and seventy-four eight-wheel and nine

ten-wheel engines, averaging twenty tons of freight to each tc
engine.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wl
11 61	12.77 Switching.	9.11	6.80 Switching.	.97	1.(Switc

J. H. Setchel, Master Mechanic Little Miami Railroad: Hav ten-wheel engines. Can give no information to assist the Comı in making a report.

William A. Robinson, Mechanical Superintendent Great We Railway, Hamilton, Ontario, Canada: Have one hundred and s teen eight-wheel engines, twenty-three six-wheel connected eng seventeen tons freight hauled to each ton weight of engine.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wh
3.79	....	7.30	....	.823	

South Side Division Atlantic, Mississippi & Ohio Railroad: I nineteen eight-wheel engines.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-whe
4.28	....	9.30	....	1.87	

William Woodcock, Master Mechanic Central Railroad of New Jersey: Have twenty-nine ten-wheel and thirty-six eight-wheel engines; eight-wheel engines haul eighteen tons freight per ton of engine; ten-wheel engines haul seventeen and one-half tons freight per ton of engine.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wheel.
5.20	4.20	6.60	7.90	.01	1.10

Received from Providence, Rhode Island, with no signature or name of road: Eighteen eight-wheel engines, one ten-wheel engine.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wheel.
.015	....	.155	....	.01	

Samuel M. Philbrick, Master Mechanic Leavenworth, Lawrence & Galveston Railroad, Kansas: We have twenty eight-wheel engines.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wheel.
3.4	....	5.1	....	.58	

J. B. Gayle, Master Mechanic Raleigh & Gaston Railroad: We have thirteen eight-wheel engines.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	1
8.43	....	37.09	....	.81	

W. G. Freeman, Master Mechanic Chesapeake & Ohio] Richmond, Virginia: We have three ten-wheel engines, fift wheel-connected four-wheel-truck, and five with three c drivers and pony truck.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	1
5.93	6.21	Not kept.	Not kept.	.96	

S. J. Hayes ` aster Mechanic Illinois Central Railroad: one hundred and eighty-five eight-wheel engines, which hau tons per ton weight of engine.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	1
8.42	....	5.94	....	....	

David Clark, Master Mechanic Lehigh Valley Railroad, : vania: We have twenty-one eight-wheeled engines; average of gross tons to each gross ton weight of engine one hunc forty-five seven-tenths tons.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wheel.
4.003	....	7.153	....	.663	

William F. Ray, Master Mechanic Toledo, Wabash & Western Railway, Indiana: We have ninety-six eight-wheeled engines; five hundred and four tons is a train.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wheel.
4.57	....	6.15	....	.80	

H. A. Alden, Master Mechanic Connecticut & Passumpsic Rivers Railroad, Vermont: We have in use on our road twenty-eight-wheeled engines. Have had no experience with any others.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wheel.
.034	....	....	....	....	

J. W. Philbrick, Master Mechanic Maine Central Railroad, Waterville, Maine: Have fifty-eight-wheel engines.

W. L. Jordan, Master Mechanic Cumberland & Pennsylvania Railroad, Mount Savage, Maryland: Have fifteen eight-wheel engines and seven ten-wheel engines; haul one hundred and sixty tons cars

over grade of one hundred and seventy-one feet per mile with te
wheel engines, one hundred and twenty tons with eight-wheel engin

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-wheel
25	6	4.5	4.5	....	

N. E. Chapman, Master Mechanic Cleveland & Pittsburgh R
road, Cleveland, Ohio: Have fifty-one eight-wheel engines and se
ten-wheel engines. Can give no information as to number of t
hauled per ton of engine, having no data to work from.

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel	8-wheel.	10-whee
3.46	5.45	5.04	6.59	.81	82

These roads employ in the aggregate eight hundred and sixty-
eight-wheeled and sixty-eight ten-wheeled locomotives.

The average cost of the two classes of engines is as follows:

Average cost per mile run in cents for

REPAIRS.		FUEL.		STORES.	
8-wheel.	10-wheel.	8-wheel.	10-wheel.	8-wheel.	10-whee
4.16	5.78	9.53	11.23	.857	1.05

Average number of tons hauled to ton weight of engine, twe
tons.

From the above statement it appears that the eight-wheel engines do the same work at a much less cost.

Respectfully,

W. L. JORDAN, *C. & P. R. R.*,
CHAS. GRAHAM, *L. & B. R. R.*, } *Committee.*
P. HOESECKER, *I. L. R. R.*,

On motion of Mr. Lauder, the report was received.

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—We are evidently not going to get through with our business to-day, and, as I understand the matter, the Convention as a body have accepted an invitation to visit the Rhode Island Locomotive Works to-morrow. I would propose that we have a night session to-night, beginning at eight o'clock, and continuing until we adjourn. We can not meet to-morrow forenoon and get through. It may be necessary to have a session to-night and another one to-morrow forenoon.

Mr. HAYES, Illinois Central Railroad—Is that intended to read that we continue in session until we get through the business to-night, or do we have another session to-morrow morning?

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—To continue until we adjourn. A motion to adjourn will be in order at any time this evening.

The motion was carried.

The Secretary offered the following resolution, which was adopted:

WHEREAS, Our worthy associate, Mr. M. N. Forney, has voluntarily and free of charge published the proceedings, circulars, and notices of the Association in the *Railroad Gazette;* therefore,

Resolved, That the Association do hereby remit Mr. Forney's dues and assessments for 1871-72.

The following Committee was appointed on "Balance Slide Valves and General Principle of Valve Motion:" Fry, Grand Trunk Railroad; Lauder, Northern Railroad, and Underhill, Boston & Albany Railroad.

The Secretary read a communication from the Bolt and Nut Manufacturers' Association, requesting the appointment of a committee to confer with a similar committee with a view of securing a standard list of nuts and washers.

THE PRESIDENT—Some two or three years ago, there was such a committee appointed, and their report was printed in the Third Annual Report of Association. What action will you take upon this?

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—I think it was at the meeting in Pittsburgh that that Committee was appointed. I was Chairman of the Committee. It reported at Philadelphia and recommended the adop-

tion of the United States standard gauge, as was recommended by the Franklin Institute, of Philadelphia, and the report of the Committee was adopted and printed at that time. A great many, I know, have adopted that standard. I did, for one, and all new work upon our road being put up with the standard nut.

Mr. HAYES, Illinois Central Railroad—I would move, as a matter of courtesy, that the same Committee be appointed to confer or meet with this Committee of Bolt and Nut Manufacturers.

Carried.

The report of the Committee on Safety Valves was read.

REPORT ON SAFETY VALVES.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee respectfully report that they have received communications from thirty-five master mechanics. Of this number twenty give a decided preference for what is known as the Richardson valve.

One prefers the Baldwin patent valve; four prefer the Anderson patent valve; one prefers the Payne patent valve; one prefers the Dawson patent valve; two prefer the old style; one prefers the Richardson, and one the old style, and two are non-committal.

Mr. R. Blodgett, Master Mechanic of the New Jersey Southern Railroad, reports that one engine sent to his road, having the Anderson valve, proved to be so unreliable that he removed it at once, while Mr. J. H. Waugh, Superintendent of Machinery of the Kansas Pacific Railway, says he uses the Anderson valve, and that it gives entire satisfaction, and is not liable to get out of order.

It is the unanimous opinion that one of the safety valves should be beyond the control of the engineer. The only objection made by any of our correspondents to the Richardson valve is the noise made when blowing off. We consider the Richardson valve, in connection with one of the old style, to be the best combination that has yet been made for use on locomotives, the Richardson valve to be adjusted by the master mechanic of the road, so that it will be beyond the power of the engineer to alter it, and one old style valve to enable him to blow off his steam at a less pressure when waiting at stations, or in case of emergency.

We do not consider that there are any good grounds for saying

; the Richardson valve relieves the pressure of steam too sud-.ly, and it does not blow off until the maximum pressure is ched, and falls certainly after blowing off of from three to five inds of steam, which variation we do not consider of any conse-ence in a pressure of from one hundred and twenty to one hun-:d and thirty pounds.

Respectfully submitted,

J. T. ROBINETTE, *A. M. & O. R. R.*,
JOHN McFARLAND, *R. & D. R. R.*
DAN. W. HAINES, *N. E. R. R.*, } *Committee.*

)n motion of Mr. Elliott, Ohio & Mississippi Railroad, the report was eived.

The report of the Committee on Place of Meeting was presented.

REPORT ON NEXT PLACE OF MEETING.

'. *President and Gentlemen:*

Your Committee, who were appointed to select names of places holding the next Annual Convention, would report the follow-; names: St. Louis, Mo.; Cincinnati; Baltimore; New York City, d Atlanta, Ga. They would also recommend that the vote be :en by ballot, each member writing the name of the place of ı choice on a ballot, and that a majority of all the ballots be the oice. They would further recommend that, if possible, the time holding the next Convention be fixed so as to not interfere with the ır-builders' Convention.

J. W. PHILBRICK,
H. L. BROWN,
WM. WOODCOCK,
JOHN F. FLYNN,
SANFORD KEELER, } *Committee.*

Mr. Robinson, Great Western Railway—Would there be any objection to ɔposing that the name of Chicago be added to the list?

The President—We can receive the report of the Committee, and then l Chicago.

)n motion, the report was received.

A motion was made to add the name Chicago, which was carried, and ırward reconsidered and lost.

Morris Sellers, late Des Moines Valley Railroad; Johann, Missouri P
Railroad, and Coolidge, Fitchburg Railroad, were appointed a committ
receive ballots.

A letter directed to Mr. Hayes, as Chairman of the Committee on
respondence, inviting the Convention to visit the warerooms of the Co
politan Solid Emery Wheel Company, was read.

On motion of Mr. Chapman, the following gentlemen were appoint
Committee on Finance for the ensuing year: Hill, Erie Railway; Cool
Fitchburg Railroad; Thompson, Eastern Railroad; Philbrick, Leavenw
Lawrence, and Galveston Railroad.

THE PRESIDENT—There are some copies of the American Locomotive
gineer presented here for inspection, with a letter accompanying
which the Secretary will read.

The letter was read, and the publications received, and the thanks
Association returned therefor.

Mr. Sellers, from the Committee appointed to receive ballots for pl
next meeting, reported:

Whole number of votes	74
Necessary to a choice	38
New York has	17
Cincinnati "	5
Baltimore "	26
St. Louis "	14
Chicago "	4
Atlanta "	8

On motion of Mr. Hayes, Illinois Central Railroad, the vote for Balti
was made unanimous.

On motion, adjourned to meet at eight o'clock this evening.

THIRD DAY—EVENING SESSION.

The report of the Committee on Associate Members was read, and, on
tion, the Association proceeded to ballot for the candidates for member

F. B. Miles, of Philadelphia; R. H. Thurston, of Hoboken; Henry
ton, of Hoboken, and J. O. D. Lilly, of Indianapolis, were elected.

Mr. James Wheelock, of Worcester, being proposed, a member inquir
any person present was acquainted with Mr. Wheelock.

THE SECRETARY—I would inquire if the provisions of our constitution permit Mr. Wheelock to be a member of the Association.

The President read the second section of the fourth article of the constitution, prescribing the qualifications for membership.

Mr. HAYES, Illinois Central Railroad—It seems to me that some one present ought to be able to say whether this gentleman has the qualifications necessary to become a member. It seems there is no one here that knows him.

THE PRESIDENT—Mr. Wheelock was recommended by Joseph Hill, Richard Colburn, and A. B. Underhill. I heard those gentlemen to-day speak of him very highly. They spoke to me about him before he was proposed to the Committee. I think none of them are present. They said they knew him, and he would be a valuable member.

Mr. Wheelock was then elected.

D. R. Tighe, recommended by George W. Glass, J. K. Taylor, and S. Moore, was submitted for ballot.

Mr. TAYLOR, B., O. C. & W. R. R.—I know the gentleman, and he is a good, worthy man. He is not engaged in mechanical business now, but is advocating the Nesmith balance valve. His home is in Boston, and his former business was machinist.

Mr. HAYES, Illinois Central Railroad—Has he ever filled the position of master mechanic?

Mr. TAYLOR, B., O. C. & W. R. R.—No, sir.

Mr. HAYES, Illinois Central Railroad—Is he a thorough mechanical engineer?

Mr. Taylor, B., O. C. & W. R. R.—He is.

Mr. GORMAN, Toledo, Wabash and Western Railway—I think we are establishing a precedent that will not work well in the future. We want here, if I understand it, four or five, or perhaps more, chemists and scientific men, that can give us information that we do not possess ourselves regarding the formation of scale, and other necessary information that will be valuable to us; but to go into an indiscriminate election of gentlemen who want to sell packing, or anything else, I don't believe is going to be a good thing for us. I think we ought to confine ourselves to the purposes of the Association—the American Railway Master Mechanics' Association. We don't want every man that comes along. This gentleman may be a good, worthy man—much better than I am—but at the same time, as we have got this Association, I think we ought to confine ourselves to that. If we want information that will be valuable to us by getting in professors of chemistry, or others that can give us information that will benefit the whole railway interest of the country, I say bring those men in.

Six negative votes were thrown, and the candidate was rejected.

The Secretary read a letter from Frederick Grinnell, which, on motion, was received:

LETTER FROM MR. FREDERICK E. GRINNELL.

PROVIDENCE, June 13, 1872.

J. H. SETCHELL, Esq., *Secretary American Railway Master Mechanics' Association:*

DEAR SIR—I am in receipt, at your hands, of the engraved copy of the resolution passed at the Fourth Annual Convention, held at Louisville, in acknowledgment of the services of myself and others in establishing the "American Railway Master Mechanics' Association."

I thank the members of the Association for the compliment paid me, and, although not likely to be again associated with them as a railway master mechanic, I shall always feel a deep interest in the success of an organization which must be of so great benefit to its members, and through them to the entire railway interest of the country. In no department of railway management is there so great need of comparison of the results of practical experience as in the mechanical department, owing mainly to the multitude of questions involved, both as to the kind of material to be used and the proper methods of disposing of it.

Any railway officer who has carefully examined the reports of the Conventions which have been held, must be convinced of the interest manifested by the members of the Association in the important work in hand, and if true to the interests of their companions, assist them in their efforts in every way possible.

With sincere wishes for the continued success of the American Railway Master Mechanics' Association,

I am very truly yours,

FRED. E. GRINNELL.

The report of the Committee on Boiler Explosions was presented.

On motion of Mr. Gorman, it was voted to dispense with the reading of the report in detail, except the conclusions arrived at by the Committee.

Mr. HAYES, Illinois Central Railroad—I was going to suggest that Mr. Sellers is present. I understand he witnessed the experiments made at Hoboken, a year or two ago, on the explosion of boilers. They took a lot of boilers and exploded them, for the purpose of ascertaining, as near as they

could, the true cause of explosions. I understand that Mr. Sellers was one of the committee who witnessed it. If he is present I would like to hear from him on the subject. If he is not here I would move that the discussion be dispensed with for the present on that subject, and that we proceed with something else until he comes in.

Mr. Gorman, Toledo, Wabash & Western Railroad—Before that question is put I will say I differ with Mr. Hayes. This is a very important matter, this question of boiler explosions. It is something of great importance, and it is getting to be more important every day; and by spending a little time on this I think we can do it with great advantage. By the time that some of our members can explain this and give their views Mr. Sellers may be here. I don't think we can spend our time to any better advantage than by trying to find the source of boiler explosions and burstings. It has come to be a question that is agitating the whole country, in steam mills as well as on roads. We hear of boilers in all sections of the country blowing up, and we ought to have sense enough amongst all of us to be able to discover the cause of this thing. We never will do it alone; we want to get the judgment and sense of the whole country upon it. I differ with a great many in regard to explosions. I have never seen but one. I have seen three bursts. I claim that there is a great difference between the bursting of a boiler and the explosion of a boiler. I am not chemist enough, and don't pretend to know what the actual cause of an explosion is, but I am under the impression that it is a combination of gases that ignite in the boiler, that are diffused through the boiler. That is my impression. It may be wrong and may not. I will not say I am right. The bursting of a boiler I have seen in three cases where I could trace the cause. I felt satisfied that I could, and do now, in my own mind. The last I knew of was on my own road. There is a peculiar theory in my mind in regard to the bursting of boilers, which is simply that there is a latent heat that accumulates in the water in the boiler. You can stand the boiler still and not disturb the water, but as soon as you disturb it there will be innumerable bubbles of water come to the surface. I have tried that in a boiler on a small scale. You can try it yourselves. It will flash out immediately; and if the safety valve is not sufficient to allow an escape there is danger of a burst.

The President—The question is on Mr. Hayes' motion, and not on boiler explosions.

Mr. Gorman, Toledo, Wabash & Western Railroad—If we could keep on with this little discussion until Mr. Sellers comes I think it would be a benefit to us. I offer an amendment that we continue the discussion until Mr. Sellers comes in.

The amendment was lost, and the motion carried.

The report of the Committee on a "Uniform System of Examination for Promotion of Locomotive Firemen" was presented.

REPORT ON UNIFORM SYSTEM OF EXAMINATION FOR PROMOTION OF LOCOMOTIVE FIREMEN, AND ADVISABILITY OF ESTABLISHING DIFFERENT GRADES OF LOCOMOTIVE ENGINEERS.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, appointed at the last annual meeting of the Association to report on the propriety of a "Uniform System of Examination for Promotion of Locomotive Firemen, also as to the "Admissibility of Establishing Different Grades of Locomotive Engineers, According to Length of Service, Character, etc.," beg leave to submit the following:

From answers received in reply to circular letter containing the following questions:

1. What is your method of promoting locomotive firemen to engineers?

2. What has been your experience as to the relative merit of locomotive engineers promoted from firemen as compared with those taken from the shop?

3. What are your views upon establishing different grades of engineers, according to length of service, merit, etc.?

4. Please state compensation allowed engineers; whether paid by month, trip, or day, also amount of service rendered for same?

1. Your Committee find that the prevalent practice is to select from among the firemen, who have fired from two and half to three years at least, one who by his record as regards sobriety, attention to duty, intelligence, and general character, gives best promise of becoming a valuable and reliable engineer in a short space of time, to give him from six months to a year's time in the shop, with occasional calls for duty on such extra running as will familiarize him with his prospective duties, and at the same time keep him as much as possible under the eye of the master mechanic, and when deemed competent an engine is given him to run.

2. Your Committee also find, that though wherever tried the promotion of shop men to locomotive engineers has in a measure given

d satisfaction in the item of the cost of running repairs being iewhat less than with the promoted firemen; yet, because of their ng possessed of the two trades, they are considered not so reliable l less attentive and obedient to orders, and so likely to give more uble than promoted firemen.

3. Your Committee find in the majority of the replies that a unim system of "grading engineers, according to length of service," ists, consisting in a division into four classes, commencing with the st and continuing through the first three years of service, when an gineer is considered first-class and is paid accordingly. We also id that on several roads an additional reward for length of service ter five years is given in an increase of pay of five dollars per onth every five years.

4. As reported to your Committee in answer, it appears that ough in many instances the compensation for services is computed r the month, yet the average service required is about one hundred iles per day, and pay ranges from $3.00 to $4.25 for same.

We have received no reply as to a uniform system of "examinan for promotion," except in two or three instances, and those opsed the idea.

Your Committee would suggest a uniform system of letters of recmendation for locomotive engineers, consisting of a printed blank be filled out by the master mechanic, stating length and class of rvice, cause of leaving, and general standing of the person holdg the recommend.

N. E. CHAPMAN,
W. F. SMITH, } *Committee.*

The President—There was referred to the same Committee the subject the "Advisability of Establishing Different Grades of Locomotive Engirs, According to Length of Service, Character, etc."

Mr. Chapman, Cleveland & Pittsburgh Railroad—Attached to that report a letter from Mr. Isaac Dripps, which I think it would be well to read connection with the report, if the members wish it.

On motion, the letter was read.

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LETTER FROM ISAAC DRIPPS ON PROMOTING FIREME GRADES OF ENGINEERS.

ALTOONA, PENN., June 8,

MR. J. H. SETCHEL, *Secretary Railway Master Mechanics' Association*

DEAR SIR—The circular from the Committee, appointed to i into the Propriety of a Uniform System of Examination for I tion of Locomotive Firemen, etc., has just been read by me. subject is one of importance I at once reply. Not having t reach the Chairman of the Committee before the sitting of th vention I send to you, for its proper disposal, this letter, givi views and the result of my experience upon the subjects of t cular as follows:

In answer to the following questions:

"What is your method of promoting locomotive firemen tc neers?"

"What has been your experience as to the merits of loco engineers promoted from firemen and taken from the shops?"

"What are your views upon establishing different grades o neers, according to length of service, merit, etc.?"

"Please state compensation allowed engineers; whether p the month, trip, or day; also, amount of service rendered for I would say that my practice has been as follows:

In the first place I pay particular attention to the selec young men for firemen, selecting none but smart, active youn of good character and perfectly sober habits. After firing fo three years, if they give evidence of sufficient capacity and c ness, I place them in the repair shop or round house for one to enable them to learn the use of tools, but more particularly come acquainted and familiar with the construction of the lo tive engine, and the manner and mode of taking its machiner and putting it together again, and pay them the same pay as fi or whatever they are worth as men working in the shop.

During the year while in the shop they are considered a young engineers of the third class, and are available to go ou the road in cases of emergency, and while out on the road rece pay of third class engineers. If, at the expiration of the yea

do not develop evidence of capacity to make efficient engineers they are not promoted, but continued either as ordinary firemen or dropped altogether. In my opinion, however, no man ought to be kept in the employ of a railroad company as a fireman who is not capable of making himself an engineer after a sufficient lapse of time.

I also, at the commencement of the fireman's fourth year, when he becomes a candidate for an engineer, and before his going into the shop, invariably insist that he should give a pledge of total abstinence from all intoxicating drinks while in the company's service.

If, at the end of the candidate's fourth year, he has conducted himself properly and given sufficient evidence of his knowledge of construction of the locomotive engine and the principles of its management to make a good engineer, he is promoted to a third-class engineer, with pay of twenty dollars per month less than that of a first-class engineer; but if not found capable he is dropped. After one year's trial as a third-class engineer, if he still gives evidence of capacity and carefulness, he is advanced one grade higher, as a second-class engineer, with pay of ten dollars per month less than a first-class engineer.

If, after the expiration of one year as a second-class engineer, he is qualified in every way for a first-class engineer, he is advanced to that grade, with first-class pay; but if not found competent in every particular for a first-class engineer he is considered out of the regular line of promotion. He might be retained as a second or third-class engineer, as his merits might determine.

I have generally found that when firemen have passed through all these grades, with proper instruction and supervision from those having them in charge, they will, as a general rule, turn out good, reliable men. This has been my experience, and I can not but think this course to be just and equitable both to men and company, as it compels the engineer to serve a regular apprenticeship to his business, and at the same time pays him liberally for his services as his knowledge of the business increases.

I have always considered it bad policy when a fireman is promoted to an engineer to give him full pay of a first-class engineer, as it is neither just to the old engineer nor to the company. We all know young engineers just promoted are more liable to accidents, and in many ways are not worth so much to the company as the old, expe-

rienced engineer is; and I have sometimes found that raising their pay at one jump has had a bad effect, as the change is so great they sometimes lose their balance and go astray. But, by following out the plan I have adopted, when a man is promoted from a fireman to an engineer his compensation is raised sufficiently for the duties he has to perform, and he has yet to look forward for further advancement both in pay and responsibility. By the time he has obtained sufficient knowledge and practice to be promoted to a first-class engineer, he will generally be found reliable, as he has then really served six years' apprenticeship at the business.

I consider the year a fireman works in the shop to be of essential benefit to himself and the company. He becomes acquainted with the manner of connecting and disconnecting the machinery of a locomotive engine, learning the use of tools, so that in case of an accident to the engine he might be running hereafter the knowledge he has acquired will be of essential service in enabling him to repair damages on the road, or getting a disabled locomotive out of the way.

I have also found that locomotive engineers promoted from firemen, as herein described, as a general rule are more reliable than machinists taken from the shops, unless the machinist has had sufficient experience as a fireman to have become perfectly acquainted with the duties of engineer.

Any man of ordinary capacity that may be selected when given six years' training, as has been my practice, will have acquired sufficient mechanical knowledge of machinery, etc., to enable him to take charge of a locomotive engine and keep it in as good order as any machinist can.

The rates of pay as I adopted for young engineers of the second and third class, as herein stated, were arranged when the regular pay for first-class engineers was rated at $90 per month, and are as follows: Three years as fireman, from $50 to $55 per month; 1 year in shop, from $55 to $60 per month; one year as third-class engineer, $70; one year as second-class engineer, $80; one year as first class engineer, $90.

Respectfully yours,

ISAAC DRIPPS.

Mr. MAYNES, Selma, Rome & Dalton Railroad—I move that the report and letter be received. I would also inquire whether it will be published in

the proceedings of the Convention. I think the letter of importance enough to be printed.

THE PRESIDENT—Yes, sir; the understanding is if it is received it will be printed with the report.

The motion was carried.

Mr. HAYES, Illinois Central Railroad—I do not now distinctly recollect whether I answered the questions of that Committee or not. In 1852, when upon the Baltimore & Ohio Railroad, under the direction of Mr. Parker, then General Superintendent, we established a system, or a Board of Examiners, to examine engineers, either from the firemen or from the shops, for promotion; and then, after the examination, if they passed we gave them a certificate—a printed certificate, signed by the three members of the Board. That system has been carried out in all my transactions in railroad matters ever since up to the present time. We have that system now in Illinois. We make a fireman, after he has fired from three to five years, apply in his own handwriting to the Chairman of the Board, or to the Master Mechanic on the division on which he is employed. After these applications are made in sufficient quantity, the Board is called together. The Board consists of the Superintendent of Machinery, or the Master Mechanic, the Division Superintendent, and the Train Master. Each one takes his turn at examining, making about forty-four questions. We ask them to describe the valve motions throughout; the meaning of lead and lap; the meaning of the exhaust; how the steam gets in and how it gets out; at what point water will boil. I examined a young man the other day and asked him at what point water would boil. He said he didn't know exactly, but he thought about four hundred degrees. We find young men that have fired long enough to know all these things that have never given it a thought from the first beginning; consequently we put inquiry into their minds, and frequently turn them back, and if we do, the next time they come up you generally find they answer every question. I have found it to be a good system, and I never yet promoted a young man from the rank of fireman that I have regretted. He has generally filled the bill from the beginning to the end, and I generally find them more attentive than those men we take out of the shops. In regard to the grading of engineers, that is all very well but when you come down to a lawsuit it doesn't work very well. If any thing should happen on the road, and the lawyer gets hold of the handle of a second-class engineer, he is going to push that suit against the company all he can. I think you had better have the system of getting the best men you can and promoting them, or letting them run in the yard as switching engineers until you find they are competent, and then give them other service and let them go out on the road. I think that system followed out works well. We have never failed in a single case. Whenever we have promoted young men of ability they have always proved themselves to be good runners.

Mr. GORMAN, Toledo, Wabash & Western Railway—I agree with Mr. Hayes partly in his statements. So far as firemen are concerned, I don't believe in keeping a man two or three years as a second or third-class engineer, I take him out on the road, and if he is a good, intelligent, smart young man there is no master mechanic but what will find it out before he has been there three years, and whether he has got any vim in him or not, I put him to switching, and if he gives satisfaction I put him on the road with the understanding that for the privilege he gets and the expense he may be to the company over an old and experienced man he will work for six months at $70 a month. At the end of that time, if he proves himself to be as efficient as any others, he goes on to the road on an equal footing with the rest. He receives first-class pay if he does first-class work. If he does not I wipe him out. I put the firemen into the engine house for six months, to give them the whole detail of the business; let them connect and disconnect, and all that kind of work. That gives them the knowledge they require in case they go on the road, in case of a smash-up. I take pains to teach these young men, and if they have not the ability to learn I send them back to fire. Then, in regard to machinists, Mr. Hayes' remarks struck me unfavorably. So far as I am concerned I never fired a day. I have thrown in a few sticks of wood, or something of that kind. The first engine I ever got onto was a little English engine, weighing about nine tons and looked to me like a stationary engine on wheels. I just got that idea in my head, and I run that engine the first trip I ever run with a train from Albany to Schenectady. I did it so well, and it happened to please them so much, that they gave me that engine to run on a wood train. A machinist ought to have as much intelligence as a fireman. Still I admit it is necessary for him to get the required knowledge by experience, if he has not got it naturally. A great many have no knowledge or judgment about starting or stopping or speed. That they must acquire by experience. That is very well; but still I don't like the expression that a machinist will not make as good an engineer as a fireman, because I believe he can if he has got any brains. I believe he can make as good a one if not better. So far as Mr. Hayes' plan is concerned I like it very well. As regards the examination, I don't believe much in that, from the fact that a fireman, if he gets bluffed the first time and don't know his lesson, will go to an old engineer and learn his lesson. He may not know the first thing about it more than the engineer tells him, but he can repeat it. It will be a kind of parrot lesson. He must learn it and know it, and that can be done only under the observation of the master mechanic. The best engineers I have got I have taken from the firemen and promoted them. I have had engineers come to me with letters that were not to be relied upon at all that claimed to be old runners. The system of promoting firemen I do indorse and intend to follow it up. I have a great many of them. Besides the apprentice boys I have in the shop, I have a number of them firing intending to make engineers of them; but I do not

ke the plan of examinations and letters and all that sort of thing. I think u must judge for yourselves.

Mr. ROBINSON, Great Western Railway—As our plan is a little different om what is adopted in the United States, it will probably not be out of ace to say more particularly, than has been mentioned in the report, just actly our way of raising our engine drivers. It will not take more than o or three minutes to explain it. In regard to selecting mechanics, it is a ost extraordinary thing, and I can not explain it, why a good mechanic es not make the best engine driver. I can not explain it, but it is a fact at they do not as a rule. Mr. Brunel, who designed the Great Eastern and d who was the engineer and master mechanic and chief of the Great Westn Railway in England, said he always chose for engine drivers men with e idea. He meant that he chose men that knew nothing else but the locotive, and I have heard that he explained that what he meant by that was is: He thought if a man knew too much about the mechanism of a locotive he spent his time in thinking, inventing, and dreaming instead of eping his eyes on the track, and his mind upon the water and the proper tion of the engine. That seems, although it was so many years ago, to ply now. Our experience amounts to the same thing. On the Great estern Railway the firemen are selected from fitters, helpers, and cleaners m the running shed. They are first of all taken into my office and there amined to see that they can read and write distinctly and legibly. If they n do that, they are of course asked other questions to see if they can disguish colors. If they show ordinary intelligence they are allowed to go ng on the yard engine. They remain there for three or four years, acding to the speed with which we have to promote men, and from that poon they are taken and in the next order of promotion put into the rung shed in the position of what we call "shed men." In that place their y is to take care of other drivers' engines during their absence, and see the raising of steam, and have care of the running shed generally; and that position they serve one, two, or three years, according to the time reired, but always more than one year. That position gives them the main portunity of becoming acquainted with the steam engine, and all the kinds engines that may be placed under their charge, and the different exigens in regard to locomotives, bringing them in and taking them out, etc. om that position they are selected, according to their ability and merit l long standing in the service, and promoted to switching engines. They then promoted in due course to engine drivers. Beyond that we make difference in the pay.

Ir. FLYNN, Western & Atlantic Railway—Mr. Robinson says he can not unt for the fact that machinists do not make as good engineers as old exenced firemen. I think I can, though I myself would prefer the machinengineers, although like the rest of the master mechanics I promote lligent and deserving firemen. The fault of the machinist is this: Know-

ing every part of the engine as he does he goes out with the idea th has nothing to learn. I know that because it was my experience. looking now at the gentleman with whom I went out to learn to run, although he may forget it I remember it well. I thought I knew s thing about running an engine, and I undertook to suggest some idea it, and he said, "Young man, you are here to learn and not to sug The great difficulty with the machinist is, he goes out of the shop belie he has nothing to learn. I have experienced that myself when I have t young men out to learn to become engineers, men I have thought somet of when I was a locomotive engineer, and endeavored to impress upon minds that they did not know how to run a locomotive engine, but that a practice of one or perhaps two months, by paying strict attention to an engineer would tell them, they would make tolerably good runners. member one instance on our road, where a young man of extra capacity machinist had a desire to learn to be a locomotive engineer and asked pe sion of the master mechanic to learn. I took him out on the road, po out to him several places where it was difficult to stop, and it was nece to have the train under complete control at the station. I told him p ularly never to attempt to come in at high speed, saying, "You may you can stop, but you will find you can not, etc." The upshot of the m was, after running with me and learning to be an engineer, at one of th tions he run into trains three times and another twice, doing more o damage every time. If we could impress young machinists who des learn to be running engineers that they have something to learn that don't know—that is, the management of the train, carrying water, cro and getting along successfully with the train—they would make successfu gineers. I rarely myself take a man out of the shop. My plan is this I see an enterprising, intelligent young man I mark him out for prom without any intimation to him. I inquire about him and take him an him to running regular trains. I don't make a switching engineer of because I don't consider that a switching engineer can run a train on the any safer than an old fireman. I require four years' service as fire Then I send him out and make him an apprentice engineer, requiring service of him for three years. I pay him the first year a little over half an engineer's pay; the second year about two-thirds; in the third full pay; and I must say I have never yet taken a young man whom I watched carefully, who kept his engine clean, etc., that has ever disappo me. Some of the master mechanics present from my section of the co have one or two of my men that I promoted, and they now stand A No the roads they are running on; one of them in particular, I believe, is th by the master mechanic equal to any man on his road. He is quite a man, having been running an engine eight or ten years. The majority promotions to engineers is from the ranks of firemen. That at one t thought was entirely wrong. I believe it now to be right. I served

trade myself seven years and four months. I went to it very young. I used to think firemen had no right to be engineers; that it did not belong to them but belonged to the machinist. I have learned a different lesson that experience has taught me. Although I regret to say it, I do not exaggerate when I say that in six cases out of ten they make a failure, and the only reason I can give is the great confidence they have in themselves. When they leave the shop to run an engine, they think they have nothing to learn; they know it all; they will receive no suggestions from older engineers, and in my opinion that explains their failure.

Mr. ROBINSON, Great Western Railway—We do sometimes put fitters out on the road, but never unless they consent to start in the rank of firemen, the same as if they knew nothing; and before a man gets to be driver he has to undergo an examination and answer certain questions which we have set and are liable to alter.

Mr. ELLIOTT, Ohio &. Mississippi Railroad—I agree with Mr. Flynn's ideas about the promotion of firemen, but I think it is a very difficult matter to lay down any rule to govern the promotion of firemen. On some roads the promotion is very slow. I have firemen that have been firemen fourteen or fifteen years, and some six or seven years, and so on, and if it was a rule to promote them whenever they had fired two or three years they would become dissatisfied. I make it a rule when I hire a fireman to hire him as a fireman; he knows if he shows ability he will have promotion; but I don't consider myself under any obligation whatever to promote him. As between taking engineers from firemen and from machinists, I think the matter is only in the shape of the head. I have known a great many good engineers made from machinists and also from firemen, and that is why we don't like to be bound by any rule. If I find a man that shows ability and is likely to make a good engineer, I keep my eye on him and try him in different places when he don't know my reason for doing so, and if he comes out all right he is promoted, and when he takes a regular train I pay him the same as other men running trains.

Mr. HUDSON, Rogers' Locomotive Works—I will add my testimony to the general character of engineers promoted from firemen, as to their being superior and more reliable than those taken from mechanics, but I think at the same time it is desirable to keep as many mechanics and make good engineers of them as we can. One of the reasons is that most of our master mechanics are recruited from that class of men. We have frequent inquiries for engineers and engine drivers to go out of the country, to South America and elsewhere, and one of the conditions is they must be mechanics; and we are unable frequently to send a class of men that would make good and reliable engineers because they are not meehanics. I think the class of educated and competent engineer mechanics is diminishing, and I must say I am sorry to see it. While, if I was employed upon a railroad at the present time, I should follow the present practice, from my whole experience as to

the better and more reliable character of engineers promoted from firemen, I must say that I regret that mechanics, as a generality, do not make first-class engineers. I don't know why it is; I do not entirely concur with Mr. Flynn, although to some extent he is possibly right; but at the same time when I went first to run a locomotive I thought I could run it as well as the next man. I think if a man with the proper qualifications goes out with the proper application he will succeed.

The report of the Committee on Printing was read:

REPORT OF COMMITTEE OF PRINTING.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee on Printing, appointed at the last annual meeting, have attended to the duty assigned them, having had the reports of last annual meeting, circulars, etc., printed at the lowest figures given by several responsible printing houses.

Respectfully submitted,

H. M. BRITTON,
N. E. CHAPMAN,
J. H. SETCHEL, } *Committee.*

The report was received.

On motion of Mr. Elliott, voted that a committee be appointed to draft resolutions; and Messrs. Robinson, Great Western Railway; Clark, Lehigh Valley Railroad, and Flynn, Western and Atlantic Railroad, were appointed by the Chair.

The report of Committee on the Best Method of Securing Driving and Truck Brasses was next presented, and read by the Secretary.

REPORT OF COMMITTEE ON BEST METHOD OF SECURING DRIVING AND TRUCK BRASSES.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, to whom was referred the question of "Best Method of Securing Driving and Truck Brasses," beg leave to report as follows:

In answer to the Committee's circular of questions, communications have been received from thirty-five master mechanics. Of this number twelve report in favor of half-round driving brasses; six in favor of brass gibs dove-tailed into the driving box; ten for the octagon-shaped brass for driving boxes; five for the half-round

rasses in three pieces, the top and center piece forming a key to ecure them in place, and two for brass gibs with Babbitt metal filled etween the gibs.

On the method of securing the brasses, five report octagon rasses secured by lugs cast in the brass, and fitted into cor-sponding recesses cast in box; one reports octagon secured by ug; one, half-round in three pieces secured with pins; five, half-und secured with pins; one, half-round secured by plug, screwed rough brass and driving box. Some of the others make no report. l using half-round who have not reported the method of fastening te "they are pressed;" those using gibs the same.

On the use of Babbitt metal, four use gibs with Babbitt; four use solid octagon without Babbitt; seven use octagon with Babbitt; r use half-round with Babbitt; four use gibs without Babbitt; en use half-round solid brass without Babbitt; four use half-round three pieces with Babbitt, and one makes no report on the use of bbitt. All, with one exception, report that the Babbitt metal uld extend the entire length of the journal, and put in in strips m ¾ to 1½ inches wide at a point between the top and front and k points of the journal-bearing; one inserts the Babbitt by drill-holes in the brass and then filling the holes with the metal.

Eighteen master mechanics report using octagon-shaped engine ck brasses; one reports using gib inserted in cast-iron; one a are box; two gibs in cast-iron and Babbitt; two report that the pe of engine-truck brasses is not important; four use a half-nd brass; one a cast-iron shell filled with Babbitt metal, and six le no report on engine truck brasses.

Ten report lugs cast in center of brass as means of securing, and bt flanges in to secure octagon-shaped brasses; one uses the square as flanges, and one reports flanges on half-round brasses; also one orts pins through the gibs to secure them; and these are all the orts made as to means of securing truck brasses.

Twelve reports are made in favor of using Babbitt in the truck sses; twelve report they do not use and do not think it advisable use Babbitt, and eleven make no report.

The best mileage reported for half-round driving brasses, without

becoming loose, was 120,000 miles; the lowest mileage 10,000 miles.

The best mileage for octagon-shaped brasses 125,000 miles; the lowest mileage was 25,000 miles.

The best mileage for brass gibs inserted in cast-iron driving boxes was 100,000 miles; the lowest mileage 75,000 miles.

The best mileage made by brass gibs (three gibs with space between them filled with Babbitt metal) 94,000 miles; the lowest mileage 71,600 miles.

The best mileage made by driving brasses in three pieces, the top and center-piece forming a key to secure them in place, 50,000 miles; the lowest mileage about one year's run, when they become loose.

The mileage made by truck brasses has not been observed, and no report has been made.

It is almost the general opinion of all that good workmanship in fitting the driving brasses into the box is of the greatest importance; that without good work brasses of all shapes will become loose and give trouble. The fitting of the truck brasses is not considered important, as no damage can result from their becoming loose.

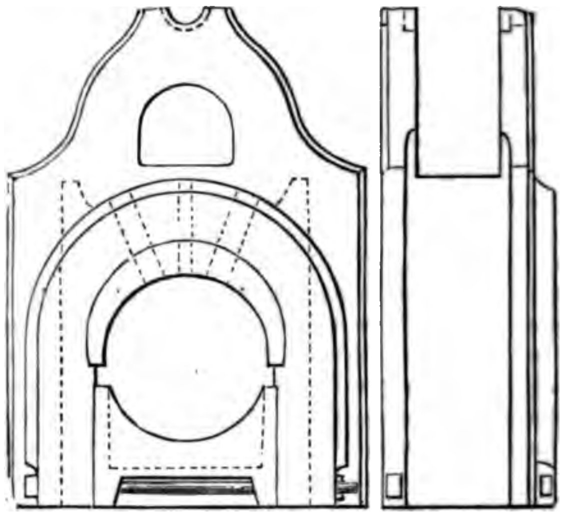
It has come under the observation of your Committee that brasses, either half-round of gibs, that are forced into the driving-box by pressure will almost always spring the box open. As the brass commences to wear at the top, the tendency of the box is to regain the original shape or position previous to the brass being forced in. If the oil-cellar is fitted tight it prevents its doing so, and the brass will then soon become loose in the box; if the oil-cellar is a loose fit, as the brass wears the driving-box will close at the bottom, and be a loose fit at that point, and make a pound which can not be taken out until the box is planed parallel. This action almost invariably takes place in engines with narrow jaws, and light driving-boxes with brasses forced in. It can be avoided by making the driving-box casting heavy enough to resist the pressure (necessary to make a tight fit) without springing open. The question then arises whether the extra weight put in the box could not be applied to a better advantage in some other part of the engine, and a lighter box be

vised in which a brass could be secured and desired results be tained.

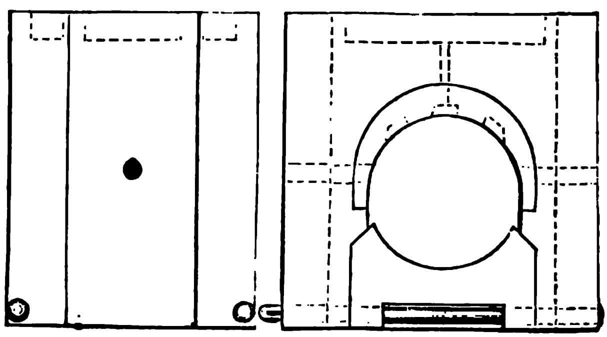
Your Committee have further observed that in engines of from irty-two to thirty-five tons weight the half round brass does not ve as good results as in lighter engines, heavy engines rarely aking over 42,000 miles without commencing to pound either in e box or brass, while light engines, of from twenty-two to twenty-x tons, will make a mileage of 80,000 miles before giving trouble. his opinion has been formed from a close observation of some fifty comotives of different weights with half-round boxes.

Your Committee are of the opinion that good results can be obined from a hexagon-shaped brass, if properly fitted. The expense doing so is greater than fitting a half-round or gib brass, as the side of the driving box should be planed out, and the brass planed fit as near as can be done on the machine, and then carefully raped until a perfect fit is made. In fitting the brass into the box e jaws of the box should be slightly sprung open—just enough to t the brass in the box—then allowed to come together with the ass in, then opened and the brass taken out and scraped where it owed it was wanted, and this operation continued until a perfect is made between box and brass, and no trouble will result from eir coming loose. The brass will wear until it is cut through into e cast-iron. Your Committee have a report of nine engines with xagon Babbitted brasses fitted in this way, the average mileage ing 85,343 miles, and all in perfect condition. One of these ennes was examined to see the condition of the brass after making ,000 miles on freight. The brass was perfect and had worn less than of an inch. Another, a thirty-five-ton engine, had made 114,014 les on heavy and fast passenger trains; brass was worn one-hth of an inch, but was perfectly tight and in good condition. ese engines have been running three years with no repairs on ving boxes or brasses. Your Committee are of the opinion that recess in the top of the brass is of great advantage, both as a ervoir for oil, and as there is less bearing at that point the brass ars away and the shaft beds itself into the brass, and there will be lost motion or pound between the shaft and brass. To secure h driving and truck brasses from working out of the box, your

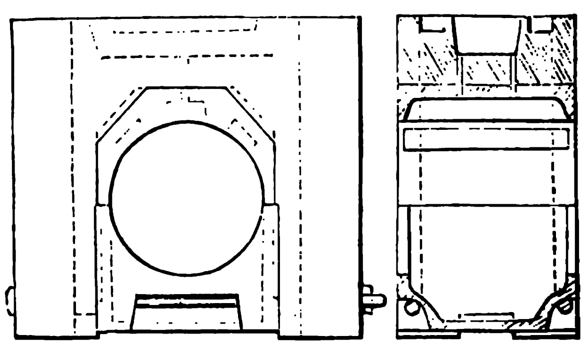
Hannibal & St. Joseph Railroad.



Atlantic & Great Western, Broad Gauge.



Pittsburgh, Fort Wayne & Chicago, Western Division.



mmittee believe that for half-round and gibs they are secured best brass pins driven through holes drilled in the box and brass; for agon, a lug cast on the brass in center of length and fitted into ess cast in the box. This is better than a flange on the ends, as thickness of the brass can be seen without taking it out. There also danger of the flange wearing off against the wheel or collar shaft.

There is considerable diversity of opinion as to the utility of using bbitt metal. Some gentlemen condemn its use while others remmend it. Your Committee are of the opinion that it is advisable use it.

Mr. Wells, of the Jeffersonville, Madison & Indianapolis Railid, expresses the opinion of your Committee. In his report he re he uses it as a "precaution against cutting." In case the box ts hot the Babbitt metal will run and prevent cutting, unless the x is neglected too long. Do not consider that Babbitt, aside m this, is of any advantage. It will wear longer than brass alone, t will wear the journal more, so what is gained in one is lost in other. The experience of other gentlemen is the same.

Herewith please find tracings of the driving box and brass used Messrs. Towne, of the Hannibal & St. Joseph Railroad; Van chten, of the Atlantic & Great Western Railroad; Meadville, and on, of the Pittsburgh, Fort Wayne & Chicago Railway.

Respectfully submitted,

JAMES M. BOON, *P., F. W. & C. R. R.,*
L. S. YOUNG, *C., C., C. & I. R. R.,*
GEORGE H. TIER, *L. S. & M. S. R. R.,* } *Committee.*

On motion, the report was received, and discussion on boiler explosions remed.

Mr. COLEMAN SELLERS, of Philadelphia—The experiments that were ied at Sandy Hook were originated by Mr. Francis Stevens and the united ilroads of New Jersey, and the intention was to test various forms of steamoat boilers, and also to try various boilers, new boilers of representative pes, as, for instance, flat surface and cylindrical boilers. The boilers they ad prepared for these experiments were four large steamboat boilers, very milar to those used on the Westfield. They also had prepared a flat slab presenting the back part of the fire-box of the Westfield boiler—an accute representation of it—and when the experiments began, in the first place.

The first trial was with one of those large boilers that had been test hydrostatic pressure up to more than double what the Governmen allow it to be run at. It was an old boiler, that had been in use f sixteen years. That was fired up without any safety-valve on i pressure pipes were carried off to a safe distance, where those who wi witness it could do so in comparative safety. Soon after the firing be steam ran steadily up until it reached a point, if I recollect rightly, fifty-six or fifty-seven pounds, when it was, I think, at about fifty-s boiler showed signs of leaking all over. The principal leak was wh large dome attaches to the boiler. Along there a seam seemed to op steam oozed in every direction, and in that condition it continued, no diminution of pressure, and gradually the fires went down, and approached all parts of the boiler were pressed out of shape. T experiment was upon a flat slab representing a part of the Westfield This was a slab 5×4, and four inches thick, stay-bolted in preci same manner as the Westfield boiler, and with the same amount of the stay-bolts—the same amount of rivet on the stay-bolts. That h tested with hydrostatic pressure, and also been tested with steam and had no safety-valve. It was fired up, and when it reached 125 we left the boiler and retired to the same distance, and in about five with 170 or 180 pounds, it exploded. It went out in the form of dis part where the stay-bolt was presenting an indentation like a mattr these parts flew out they wounded two or three other boilers. Ev bolt was drawn out of its hole. No stay-bolt was injured in the degree on its thread, but every hole in which a stay-bolt was dr enlarged sufficiently to allow the stay-bolt and its head to come out the inside of the surface were curious marks, as if it had been in a lathe, and marked with what is called lathe work on the back and We thought they might indicate lines of strain. On the second d not present, but I received accounts of the experiments and rememb One of those large steamboat boilers was fired up that was considere run at 30 pounds. It had been tested up to 60 pounds by hy pressure. It was in thoroughly good condition. They fired it up was 35 pounds and left it. In fifteen minutes from the time they l steam ran up until it reached somewhere about 52 pounds, when th thing went to pieces with a fearful explosion. The dome was car hundred feet to one side, and the whole boiler was flattened destroyed, representing an almost exactly similar case to the Westf possibility of a boiler having a safety-valve so stopped that it c relieve the pressure, and then being left with only ordinary force f minutes. I saw the officers of the Pennsylvania Railroad after the ments, and was very desirous that the experiments should be co

after the Pennsylvania Road had taken charge of the New Jersey Road. They told me they did not think it was worth their while to spend any more money in that direction; that they themselves had already made experiments almost exactly the same as those being tried by Stevens. After diligent inquiry I found that all the documents connected with the experiments on the Pennsylvania Road were accessible. They were in the form of letters written to Mr. Cassatt, I think, or Mr. Thomson, I am not sure which. Those letters were written, and Mr. Enoch Lewis, the General Purchasing Agent of the Pennsylvania Road, in former days General Superintendent, prepared a report from those letters, which was published in the *Franklin Institute Journal.* The substance of the experiments can be stated in a very few words: A locomotive which was condemned, and had been intended to be taken to pieces, was run out on a side track off from Altoona in the woods, and they determined to try an experiment, which they had always desired to see tried, namely, the firing of a boiler until the steam was very high, then blowing it out so as to expose the top of the crown-sheet, and allow it to become red-hot, and with a large steam fire-engine force water into that engine. They fired it up and retired to a safe distance. They saw the pressure-guage go up to 125 pounds, if I remember rightly; then the lock-up safety-valve blew off, showing it was not weighted heavily enough. They had no means to determine, except by guess, how much to screw it down, and they did it merely by guess and retired a second time, thinking they could then go on with the experiment as they intended; but they had hardly gone from the boiler—they were not five minutes away from the boiler—when the pressure-guage hand seemed to run round as rapidly as anything could be until it reached something near to 200 pounds, when the engine blew to atoms. It was full of water, with every condition that would insure safety except that the pressure was a great deal too great for the strength of the material composing it. No other reason could be given for the explosion. They then took a second engine and treated it in the same manner, but that one happened to be strong enough to sustain the pressure they desired. They blew the water out, and when the glass guage indicated that it was below the crown-sheet they allowed it to stand long enough for the crown-sheet to be red-hot, and pumped water into it, and in pumping this water in it behaved as I have seen it. The steam merely went down. Once or twice or three times they repeated it. The boiler was injured by the fire, but it did not explode it or do any harm to inject large quantities of cold water into the very much overheated boiler. In the experiments at the Harrison Boiler Works, with cast-iron boilers, many gentlemen present on that committee of the Franklin Institute were anxious to see this experiment of a red-hot boiler having water suddenly injected into it tried with a cast-iron boiler. They had already fired one of them up to a pressure of 170 pounds.

One of those same boilers was fired up to 150 pounds, the blow-off cock w opened, and the whole of the steam discharged. We waited then ten mi utes, and heated the furnace so that a stick of wood put against the boil would immediately become ignited, and we injected the water in. B instead of making steam it cooled off the boiler. We waited for steam, ble it off again, and three times we repeated that experiment, and during th whole time I was standing within five feet of that boiler, with my hand on i most of the time, and it behaved just exactly as a mass of iron of that siz should have behaved; that is, the water passed into it, merely cooling off th iron, and doing nothing else. The experiment was very interesting, an very conclusive that the whole mass of the boiler, if heated red-hot, does no contain heat enough to raise the water the boiler will hold up to the stea point. I think that covers the matters I have to tell you.

Mr. HAYES, Illinois Central Railroad—I would like to ask Mr. Seller one question: Have you not a theory of your own on the general cause of the explosion of boilers?

Mr. SELLERS, of Philadelphia—I have a theory of my own.

Mr. HAYES, Illinois Central Railroad—I would be glad to hear it.

Mr. SELLERS, of Philadelphia—My theory is that the pressure in the boiler is too great for the strength of the material. [Great applause.]

Mr. HUDSON, Rogers' Locomotive Works—I believe that is a matter of fact rather than theory.

Mr. FRY, Grand Trunk Railway—I feel a little delicate in asking the question, but the expression was so unanimous when Mr. Sellers gave his opinion as to the reason that boilers explode, and there was such a general feeling that he had given the right and true mechanical explanation of it that I should like to know whether the report as read is to be published in the minutes of this Convention. It seems to indicate, at least I understan it so, that the cause of boiler explosions is something we do not understanc and that in merely looking to superior workmanship and superior materia we are looking in the wrong direction. I may have misunderstood the re port, but several members understood it the same way. I should like t know whether that is to be published as the opinion of this Convention.

THE PRESIDENT—All reports received are published in the minutes.

Mr. HUDSON, Rogers' Locomotive Works—I will say, and I think I hav said before on this same subject, that it is undoubtedly the great strain tha causes these boilers to give way. There is no question about that, and don't know any way to prevent it except by using the best material we ca get, and I think I have said before, putting it together in the best possibl manner, and then taking care of it as well as we can. Now, while I do no wish to say that there is no such thing as a mysterious and incomprehensibl explosion, I do say I have never seen a case where a boiler had explode

when I had an opportunity of examining it immediately afterwards, but I could assign a good and sufficient reason why and where it gave way. I have never seen anything yet to convince me that there is any decomposition of the water in a boiler that can by any possibility make a gas which can explode or be exploded so as to destroy the boiler. If it is said that the decomposition of the water may take place by the absorption of the oxygen, then we have hydrogen in the boiler, and it is a well-known fact that hydrogen gas, in equal degrees of temperature, exerts a less expansive force than so much steam; therefore the generation of hydrogen would not increase the expansive force in the boiler but diminish it. Then for hydrogen to become explosive it wants a quantity of oxygen with which it has just parted into the iron. It appears to me those chemical operations go to work in the easiest way. In other words, they select for themselves the shortest and easiest way of making a combination. I do not think the hydrogen would leave the water and go into the iron and then back into the water to make an explosion. I do not say that boilers may not be exploded by perhaps an insufficiency of circulation, or by allowing the boiler to stand until the plates become superheated and throw the water into a spheroidal state. I think that is one cause which may be assigned in some cases; but that boilers explode from any such cause very seldom. I think I have known of one or two cases where I could not assign any other reason. They were not cases, however, that I had an immediate opportunity of examining after the boilers had exploded; but from all the circumstances I could learn that appeared to me to be the only rational conclusion. I do say the only thing is good material, reliable workmanship, thorough staying, and then good care. I say that is the direction in which to look to prevent boiler explosions.

Mr. Philbrick, Maine Central Railroad—I commenced my experience with a boiler under rather unfavorable circumstances. I was called upon to put up an engine in a small steamboat. I put it together, having a man with me who was to be the engineer. I ran it the first day on an experimental trip. The second day the man suggested, as he was to be the engineer and I had done my work satisfactorily to him, it would be proper for me to let him run the boat that day. I had gone down and put on my overalls as usual, not thinking he was sensitive about it; and when he suggested it, I said, "All right; I never designed to run the boat, and if it is put together satisfactorily I will leave it." I left it, and in about an hour I heard the boat had gone up with the engineer. Then came the coroner's investigation, and we happened to have some men that knew all about engines and thunder and lightning, and a good many other things, and the matter was pressed very hard. It was pressed very hard before the coroner's inquest, so much so that I made some preparations and went about gathering about a gallon measure of something that was invisible, by plunging hot iron into water and catching the result. I accumulated enough in there to occupy nearly a gallon's

space. That I carried to a professor of chemistry, who is now President the Lewistown University, Dr. Loomis. We put a little of it in a glass tu and applied a match to it and it went off like powder. He said, "You ha some gas there, and if I introduce a little more air and mix oxygen with there would be an explosion of more magnitude." Then he let in a little and applied a match, and there was not any explosion. "Well," said h "there is not so much gas there as I thought there was," and by a pretti and nicer analysis of it, it proved to be a very small portion of hydrog that had come from the decomposition of the iron, and a very much larg portion of atmospheric air that had gone in with the iron into the vessel. I found no indication there of anything that was more troublesome than tha a very small portion of hydrogen obtained by the decomposition of the iro and nothing else that was more dangerous.

Mr. GRANT, late Rockford, Rock Island & St. Louis Railroad—For sev eral months, nearly since January, with the exception of some time I ha been sick, I have devoted myself almost exclusively to the subject of stea boiler explosions. I have perused several works, and have consulted wit something like seventeen or eighteen men whom I considered were m superiors—men of intelligence, men that were scientific, and two profess of chemistry. I have become satisfied from consulting with them that the is a gas that is formed in boilers that we know nothing about. I did n get up here to make a speech, because I am no speaker. In fact I am ver timid. Mr. Jauriet has asked Mr. Hays to prepare a paper to be read befo this Association. As he is not here I would ask permission to have read.

A motion to have the paper referred to read was lost.

Mr. GRANT, late Rockford, Rock Island & St. Louis Railroad—I am sorr this action has been taken. I think it is treating our subject very lightly. think it is a matter we ought to consider, if we are trying to find out the re cause of boiler explosions. I do not think it will hurt us any to hear read.

Mr. GREGG, Erie Railway—I notice by that clock, and I suppose that Boston time, that it is growing late. We certainly have considerable wo to do yet before we close, if we close to-night at all. I hardly think we sh come to any conclusion about boiler explosions if we stay all night. I wi mention simply one case. It is the first I have any recollection of at all the first locomotive boiler explosion—and that occurred on the Erie Ro about thirty-two years ago, and created a great excitement at the tim because it was perhaps the first locomotive boiler explosion that occurred this country. The railroad people appointed several committees to inves gate the cause of that explosion, made up of the best scientific men th could find in the country. Among other men employed was Profes

Johnson, of Philadelphia. I presume our friend Sellers has some recollection of the circumstances. That committee, after continuing the investigation some considerable time, came to the very grave conclusion (there was a thunder-storm at the time the explosion took place) and I presume that it is on the records of the Franklin Institute, that the locomotive was struck by lightning, and that caused the explosion! Now, gentlemen, I say to you here if we stay all night we will not arrive at any better conclusion than Johnson did thirty-two years ago when he decided that the boiler was struck by lightning, and that caused the explosion. I move that this discussion close.

Mr. GLASS, Allegheny Valley Railroad—I was in the employ of the company when that explosion occurred, and to all practical men it was attributed to cast-iron bars on top of the crown-sheet. [Laughter.]

The motion was carried.

RESOLUTIONS OF THANKS.

Mr. Robinson, from the Committee on Resolutions, presented the following, which were adopted:

Resolved, That this Convention do tender their sincere thanks and appreciation to the Bay State Iron Works for the agreeable excursion down the Boston harbor; to the Committee of Reception, Messrs. Leach and nineteen others, for the pleasant drive through the suburbs of the city, and their entertainment at the Boston Theater; to the Rhode Island Locomotive Works, with which we specially mention the courteousness of B. W. Healey, Esq., the Superintendent of the Rhode Island Works, for their liberality in providing an excursion from Providence to Rocky Point; to the Boston & Providence Railroad Company for the facilities rendered to the Convention by providing a train from Boston to Providence and return; to the railways concerned in providing a free passage for the members of the Convention to the New Hampshire Hills; also, to the city press of Boston for the kindness extended by them to the Convention in various ways.

FUND FOR PREMIUMS FOR DRAWINGS.

Mr. FORNEY, Railroad Gazette—The Association during my absence passed a vote remitting my fees. For what reason this was done I am at a loss to know. I believe the reason attributed was that there had been some imaginary service rendered the Association which for some reason, they conceived they where indebted to me for. I somewhat regret the action taken by the Association, but as it is done, I propose to do what I had in contemplation, but what I could not see my way clearly to do, which is to begin a fund to be given as a premium for the best drawing of a machine for removing snow from the track, and another for supplying locomotives with water

and fuel. My object in doing this is to encourage the craft of which I was once a member—that of draughtsmen. I presume all the gentlemen here appreciate how important it is to a shop to have a competent draughtsman. My object is to encourage them and bring here a number of drawings which will also be useful in themselves. I move that a committee of three be appointed to determine at our next meeting which are the best designs for the purposes I have mentioned. I would also like to add, if there are any gentlemen who feel disposed to increase that fund by any additions to it, I hope they will now come forward with their contributions.

Mr. ROBINSON, Great Western Railway—There are two points in the subjects for our next convention where there is a sum of money authorized and a dash put there and no sum mentioned. Will it require the action of the Convention or will a committee do? I move a committee be appointed on premiums.

THE PRESIDENT—The Convention has appropriated no money as yet.

Mr. HUDSON, Rogers' Locomotive Works—I will add an equal amount to Mr. Forney's.

Mr. FLYNN, Western & Atlantic Railroad—I will give the same amount.*

The motion was agreed to, and Messrs. Forney, Hudson, and Sellers appointed.

OFFICERS FOR ENSUING YEAR.

Mr. KEELER, Flint & Pere Marquette Railroad—As it is perfectly competent for the Association to do so, I move that the election of officers be postponed for one year, until the next regular meeting.

THE PRESIDENT—I hardly know how to put that question. I don't know whether that is constitutional.

Mr. GREGG, Erie Railway—I think it is perfectly constitutional. The officers have not yet held office for one year, and I don't see how we have any right to elect officers to-night.

THE PRESIDENT—The constitution provides, "The officers shall be elected separately by ballot, at a regular meeting, and a majority of all votes cast

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* The following gentlemen subsequently subscribed to this fund the sums opposite their names:

Mr. W. A. Robinson, Great Western, of Canada	$10.00
Mr. Gordon H. Knott, Consulting Engineer, Boston	10.00
Mr. R. C. Blake, Manufacturer of Steam Guages, Cincinnati	10.00
Mr. M. W. Snow, Ramaho Wheel Works	10.00
Mr. Wm. B. Bement, Manufacturer of Mechanics' Tools, Philadelphia	10.00
Mr. I. A. Williams, Manufacturer of Head-lights, Utica, N. Y	10.00
Mr. Coleman Sellers, of Wm. Sellers & Co., Philadelphia	10.00
Mr. F. B. Miles, of Ferris & Miles, Philadelphia	20.00

Persons disposed to add to this fund can send their contributions to the originator or at the office of the RAILROAD GAZETTE.

shall be necessary to a choice. The officers shall be elected for a term of one year, but in the event of the election being postponed shall continue in office until their successors shall be elected." I will say to the Convention it was my intention to resign at this meeting, and so stated in the short address I delivered; but if it is the unanimous wish of this Convention that myself and associates should remain, I will do all that I can for the Association. I will put the motion, and will determine then whether or not I will serve.

The motion was unanimously passed.

TABLING REPORT ON BOILER EXPLOSIONS.

Mr. FRY, Grand Trunk Railway—A good many of the members have come to me, and most of them are old members, and requested it that I propose we reconsider the acceptance of the report on boiler explosions. The general feeling seems to be that the subject is of vast importance. Our acceptance was passed over before we had discussed it, and before we heard the valuable facts that Mr. Sellers laid before us. We do not undervalue the report, but we feel the subject is of too great importance to be decided hastily, and if we send out an expression of opinion that we do not all, or a large majority, coincide in we shall assume a false position. I think we ought to make the reports coincide with the opinion of most of the members present, so the managers of roads may think, in reading these reports, that their master mechanics are aiming at some valuable facts. I think it would be rather unwise to publish mere opinion when we can arrive at some definite facts. I move to reconsider the motion, and that the report be laid on the table, and no definite report be printed until we have discussed the matter more fully at other meetings.

The motion to reconsider and to lay on the table were both carried.

MISCELLANEOUS BUSINESS.

The following members were appointed a committee to make arrangements for the next annual meeting at Baltimore: G. W. Perry, Philadelphia, Wilmington & Baltimore Railroad; E. H. Williams, M. Baird & Co., and W. Woodcock, Central Railroad of New Jersey.

Mr. GRANT, late Rockford, Rock Island & St. Louis Railroad—Inasmuch as the report of Committee on Boilers has been reconsidered and laid on the table, if I am able to be present at our next annual meeting I shall feel as John Quincy Adams did about forty-four years ago on the right of petition, I shall ask the privilege then, if I am in order, of bringing up the subject.

Mr. HAYES, Illinois Central Railroad—I would move that this Conven-

tion donate to the Secretary, as his duties have been very arduous, the sum of $500 for his services.

Carried.

Mr. ROBINSON, Great Western Railway—I suggest, in order to make our conventions a little more pleasant—of course they are very pleasant, useful, and scientific as they are now—that we each of us try to bring a drawing or model of anything that we have found since the last Convention, or that has occurred to us as new, that we think will be interesting and new to some of the members, who may thus have the pleasure and the utility of gaining information upon the subjects to which they refer. They will also be interesting and instructive to any visitors who may come among us. I would also recommend that a committee be appointed to look after them and hang them around the room. You would be astonished how very interesting a convention of this kind can be made. I mention it because it is the practice of similar associations in the old country. It is astonishing to see the number of ladies that come to visit the rooms, besides the dignitaries of the towns—in fact every kind of person who has any ideas of progress.

THE PRESIDENT—I was in hope that you would say you hoped every member would bring a lady with him.

Mr. ROBINSON, Great Western Railway—I think most of us would enjoy that too.

Mr. MAYNES, Selma, Rome & Dalton Railroad—Would it not be well to have some limit to the size of these drawings, so they can be filed in a book, or in book form, in which they can be retained among the books of the Association? We can not frame them and then carry them all over the country to hang them up; but let a size be adopted and they can be kept conveniently.

Mr. ROBINSON, Great Western Railway—It has been suggested to me (and is a matter between us, as the Committee on Resolutions) that one of the most important things of that kind is a resolution of thanks to our worthy Chairman. For my own part and on the part of a great many others in this room I am very sure—at least I say so for myself and I think others will bear me out—I don't think there is a person in the Association who would fill the office so well as our present Chairman. I have been to hundreds of meetings, and I don't think I have ever saw so much business done in so little time and in so pleasant, courteous, and winning manner as by our Chairman. I propose this resolution:

Resolved, That we tender our Chairman our hearty and sincere thanks the very kind and courteous manner in which he presided over this Association.

The question was put by the Vice-President and passed unanimously.

THE PRESIDENT—I don't know what to say. I am happy to know that you are pleased. I don't pretend to deny that I have tried to please you and do the best I could. For my own part I have a pride in that of course. All that I care for, all that I want to know is, that you are pleased. I will endeavor to serve you while I am your President in the best manner possible, so far as I know.

Mr. HAYES, Illinois Central Railroad—I move we now adjourn to meet in Baltimore the second Tuesday of next May.

THE PRESIDENT—Before I put that motion, let me urge upon you all to be particular during the coming year to answer promptly every circular that is sent to you. I will say here that as soon as the minutes of this meeting can be printed the committees will be notified of their appointment. The men whose names are first on the lists will be the chairmen of the committees, and they are requested to get up their questions and send them to the Secretary to print. He will distribute them from his office. Before I put that motion, allow me to suggest one other thing. There has no Committee on Printing been appointed. Shall the Committee of last year be continued?

Mr. Hayes moved that the committee be continued, which was carried.

THE PRESIDENT—There is another very important thing that I don't want you to forget, that every member as soon as he reaches his home will send his name in full and his post-office address to the Secretary. A letter addressed to J. H. Setchel, Cincinnati, will reach him; also the names of all the foremen under their charge, and the officers of the roads whom they want reports sent to. There has been some little complaint of reports not reaching the members. It is for the want of not knowing their addresses. The Secretary has spent a great deal of time in endeavoring to get a correct list of the addresses of the members, but there have been a great many changes on railroads, and he is at a loss to-day to know the addresses of many of the members. We copy a great many from the *Railroad Gazette* which has a very correct list of appointments and resignations. We try in every possible way to keep the addresses correct, but it is a good deal of work, and if members will bear in mind to send their post-office addresses and the name of the road it will facilitate the business very much.

Mr. ROBINSON, Great Western Railway—Would it not save considerable time if he should send four copies to each master mechanic.

THE PRESIDENT—There are some roads that want about ten and others two or three. We had 1,500 copies printed last year.

Mr. GRANT, late of Rockford, Rock Island & St. Louis Railroad—I believe the reports Nos. one and two are exhausted, are they not? I have heard quite a number of members express a wish to have the first and second numbers of our proceedings. I for one would like a copy and will be willing to share the expense of having them reprinted.

THE PRESIDENT—The first report contained but sixteen pages, the second about eighty pages, and they are all exhausted. I believe I did recommend on the opening of this Convention that the first and second be reprinted, and the four bound in one volume. Many of the members have them bound in that form, and it makes a very handsome book, one that no one need be ashamed to have in his library. If it is the wish of the Convention they can have it done, or it can be done hereafter.

The motion of Mr. Hayes to adjourn was then carried.

COMMITTEES AND SUBJECTS FOR DISCUSSION AT NEXT ANNUAL MEETING.

Locomotive Boiler Construction.

S. J. HAYES, Illinois Central;
J. LOSEY, Louisville, New Albany & Chicago;
J. B. GREGG, Erie.

The Operation and Management of Locomotive Boilers, Including the Purification of Water.

H. A. TOWNE, Hannibal & St. Joseph;
A. H. DECLERCQ, Toledo, Peoria & Warsaw;
HARRY ELLIOTT, Ohio & Mississippi.

The Comparative Value of Anthracite Coal, Bituminous Coal, and Wood for Generating Steam in Locomotives.

CHARLES GRAHAM, Lackawanna & Bloomsburg;
L. S. YOUNG, Cleveland, Columbus, Cincinnati & Indianapolis;
B. H. KIDDER, Lake Shore & Michigan Southern.

The Construction, Operation, and Cost of Maintaining Continuous Train-brakes.

J. M. BOON, Pittsburgh, Fort Wayne & Chicago;
J. JOHANN, late of Missouri Pacific;
W. S. HUDSON, Rogers' Locomotive Works.

The Relative Cost of Operating Roads of Gauges of Three Feet Six Inches or Less, and those of the Ordinary Four Feet Eight and a Half-inch Gauge.

J. T. ROBINETTE, Atlantic, Mississippi & Ohio, South Side Division;
J. U. EASTMAN, Nashville & Chattanooga;
W. BELL SMITH, South Carolina.

The Construction and Operation of Solid-end Connecting Rods for Locomotives.

J. SEDGLEY, Lake Shore & Michigan Southern;
J. W. NESBITT, Evansville, Terre Haute & Chicago;
N. E. CHAPMAN, Cleveland & Pittsburgh.

Resistance of Trains on Straight and Curved Tracks and on Wide and Narrow-guage Roads, and with Four and Six-wheeled Trucks and with Long and Short Wheel-base.

W. A. ROBINSON, Great Western of Canada;
WM. JACKSON, Rome, Watertown & Ogdensburg;
C. T. HAM, late of New York Central & Hudson River.

The Efficiency of Check or Safety Chains on Engine, Tender, and Car Trucks in Lessening the Danger Resulting from Running off the Track.

R. WELLS, Jeffersonville, Madison & Indinnapolis;
C. R. PEDLLE, St. Louis, Vandalia, Terre Haute & Indianapolis;
J. L. WHITE, Evansville & Crawfordsville.

The Machinery for Removing Snow from the Track.

J. W. PHILBRICK, Maine Central;
J. N. FOSS, Vermont Central;
E. STUDLEY, late of Concord.

The Machinery and Appliances for Supplying Fuel and Water to Locomotives.

H. L. LEECH, Hinkley & Williams Locomotive Works;
WILSON EDDY, Boston & Albany;
E. GARFIELD, Hartford, Providence & Fiskhill.

The Machinery and Appliances for Removing Wrecks and Erecting Bridges.

MORRIS SELLERS, of Pittsburgh;
D. O. SHAVER, Pennsylvania;
S. MOORE, Pittsburgh, Fort Wayne & Chicago.

The Best Form and Proportion of Axles for Cars and Locomotives, also Whether there is Anything to be Gained by the use of Compound Axles and Loose Wheels.

N. M. FORNEY, Railroad Gazette;
COLEMAN SELLERS, Philadelphia;
GORDON H. NOTT, Boston.

Anti-friction Valves and Valve Gearing.

HOWARD FRY, Grand Trunk of C. W.;
A. B. UNDERHILL, Boston & Albany;
JOHN THOMPSON, Eastern of Bostc

Compression Brakes.

A. MITCHEL, Lehigh Valley;
C. GRAHAM, Lackawanna & Bloomsburg;
C. B. STREET, Pennsylvan

Steel Tires.

J. N. LAUDER, Concord & Claremont;
F. A. WAITE, Boston & Maine;
GEO. H. GRIGGS, Worchester & Nash

Finance.

E. O. HILL, Erie;
GEO. A. COOLEDGE, Fitchburg;
S. M. PHILBRICK, Leavenworth, Lawrence & Galvest

Printing.

H. M. BRITTON, White Water Valley;
N. E. CHAPMAN, Cleveland & Pittsburgh;
J. H. SETCHEL, Little Mia

Arrangements for Next Annual Meeting.

G. W. PERRY, Philadelphia, Wilmington & Baltimore;
E. H. WILLIAMS, Baldwin's Locomotive Works;
W. WOODCOCK, Central, of New Jer

Premiums.

M. N. FORNEY, Railroad Gazette;
W. S. HUDSON, Rogers' Locomotive Works;
COLEMAN SELLERS, of Philadelph

General Supervisory Committee.

H. M. BRITTON, White Water Valley;
N. E. CHAPMAN, Cleveland & Pittsburgh;
J. B. PENDLETON, Seaboard & Roanoke;
J. H. SETCHEL, Little Miam

CONSTITUTION AS AMENDED AT FIFTH ANNUAL MEETING, BOSTON, JUNE 11, 1872.

PREAMBLE.

We, the undersigned, Railway Master Mechanics believe that the interests of the Companies by whom we are employed may be advanced by the organization of an Association which shall enable us to exchange information upon the many important questions connected with our business. To this end we do establish the following

CONSTITUTION.

ARTICLE I.

Section 1. The name and style of the Association shall be the American Railway Master Mechanics' Association.

ARTICLE II.

Sec. 1. The officers of the Association shall be a President, a First and Second Vice-President, a Secretary, and a Treasurer.

Sec. 2. The above-named officers shall be elected separately, by ballot, at a regular meeting, and a majority of all votes cast shall be necessary to a choice.

Sec. 3. The officers shall be elected for a term of one year, but in the event of the election being postponed shall continue in office until their successors shall be elected.

Sec. 4. Two tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE III.

Sec. 1. It shall be the duty of the President to preside in the usual manner at all the meetings of the Association, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members of the Association, and the name of the road they each represent; to receive and keep an account of all money paid to the Association, and at the close of each meeting deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills against the Association, and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same; to keep an accurate book account of all transactions pertaining to his office.

ARTICLE IV.

SEC. 1. The following persons may become members of the Association by signing the Constitution, or authorizing the President or Secretary of the Association to sign for them, and paying the initiation fee of one dollar: Any person having charge of the Mechanical Department of a Railway, known as "Superintendents," or "Master Mechanics," or "General Foremen," the names of the latter being presented by their superior officers for membership.

SEC. 2. Civil and Mechanical Engineers and others whose qualifications and experience might be valuable to the Association may become Associate Members by being recommended by three active members. Their names shall then be referred to a committee, which shall report to the Association on their fitness for such membership. Applicants to be elected by ballot at any regular meeting of the Association, and five dissenting votes shall reject. The number of Associate Members shall not exceed twenty. Associate Members shall be entitled to all the privileges of active members excepting that of voting. Also, two Mechanical Engineers or the representative of each Locomotive Establishment in America.

SEC. 3. Any person who has been or may be duly qualified and signs, or causes to be signed, the Constitution, as member of the Association remains as such until his resignation may be voluntarily tendered.

SEC. 4. All members of the Association will be liable for such dues as may be necessary to assess to defray the expenses of the Association.

ARTICLE V.

Sec. 1. The regular meeting of the Association shall be held annually on the second Tuesday in May.

Sec. 2. Regular meetings shall be held at such place as may be determined upon by a majority of the members present at the previous meeting.

Sec. 3. An adjourned meeting may be held at any time and place that a majority of the members present at any meeting may elect.

Sec. 4. The regular hours of sessions shall be from 9 o'clock, A. M., to 2 o'clock, P. M.

ARTICLE VI.

Sec. 1. This Constitution may be amended at any regular meeting of the Association by two-thirds vote of the members present.

NAMES AND ADDRESS OF MEMBERS OF AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Anderson, H	Late of C. & N. W. R. R., Chicago, Illinois.
Adams, G. Q	M. I. & W. R. R., Alexandria, Missouri.
Aden, H. A	C. & P. R. R., Lyndon, Vermont.
Anderson, J. H	N. Y. P. & B. R. R., Providence, R. I.
Adams, Ralph	B. C. & M. R. R., Lake Village, N. H.
Britton, H. M	W. W. V. R. R., Cincinnati, Ohio.
Beattie, J. G	S. M. & N. R. R., Sandusky, Ohio.
Brown, F. A	D. L. & W. R. R., Ithaca, New York.
Brown, M. E	Erie R. R., Buffalo, New York.
Bn, J. M	P. F. W. & C. R. R., Fort Wayne, Indiana.
ck, John	D. & M. R. R., Lima, Ohio.
r, R. B	T. & N. O. R. R., Houston, Texas.
ke, M	M. & C. R. R., Memphis, Tennessee.
terfield, J. G	St. P. & S. C. R. R., Shacopee, Minnesota.
hnell, R. W	C. & N. W. R. R., Chicago, Illinois.
ar, M	F. & N. S. R. R., Flushing, New York.
sto, L. C	L. & S. R. R., Wilkesbarre, Pennsylvania.
wn, H. L	Erie R. R., Jersey City, New Jersey.
ant, Wm. H	Ft. W. & C. R. R., Fort Wayne, Indiana.
sett, F. A	M. & L. R. R., Memphis, Tennessee.
tis, Josiah	N. O. M. & T. R. R., Mobile, Alabama.
mley, R	Cincinnati, Ohio.
lock, C. F	Late of O. C. & N. P. R. R., Boston, Mass.
kall, R. C	A. & S. R. R., Albany, New York.
ttie, J. Y	S. M. & N. R. R.

Burroughs, A. P..................M. & O. R. R., Marquette, Michigan.
Boyden, G. E....................B. H. & E. R. R., Boston, Massachusetts.
Brooks, H. G......................Brooks' Locomotive Works, Dunkirk, N. Y.
Cullen, Wm.......................C. H. & D. R. R., Cincinnati, Ohio.
Cooper, W. E.....................Erie R. R., Hornellsville, New York.
Chapman, N. E...................C. & P. R. R., Cleveland, Ohio.
Cummings, S. M.................P. Ft. W. & C. R. R., Allegheny, Pennsylvania.
Coolidge, G. A...................F. R. R., Charlestown, Massachusetts.
Cooper, H. L......................K. C. St. Jo. & C. B. R. R., Kansas City, Mo.
Cushing, G. W...................N. P. R. R., St. Paul, Minnesota.
Congdon, A.......................Late of L. S. R. R., Cleveland, Ohio.
Connell, T.........................B. C. & P. R. R., Corry, Pennsylvania.
Clark, D............................L. V. R. R., Hazleton, Pennsylvania.
Church, F.........................T. & B. R. R., Troy, New York.
Collings, E........................C. & A. R. R., Camden, New Jersey
Colburn, R........................N. & W. R. R., Norwich, Connecticut.
Cook James........................Danforth & Cook's Locomotive and Manufacturing Co., Patterson, New Jersey.
Calhoun, J. E....................St. L. K. C. & N. R. R., St. Louis, Missouri.
DeClercq, A. H.................T. P. & W. R. R., Peoria, Illinois.
Danfield, S. D....................P. & B. C. R. R., Chester, Pennsylvania.
Devine, J. T......................W. & W. R. R., Wilmington, North Carolina.
Durgin, J. A......................Pittsburgh Locomotive Works, Pittsburgh, Pa.
Drippes, Isaac....................P. R. R., Altoona, Pennsylvania.
Davies, T. S.......................M. & St. P. R. R., Milwaukee, Wisconsin.
Davies, D. T......................V. & M. R. R., Fitchburg, Massachusetts.
Duncan, W.........................B. B. & G. R. R., Worcester, Massachusetts.
Eddy, Wilson......................B. & A. R. R., Springfield, Massachusetts.
Elliott, Henry....................O. & M. R. R., East St. Louis, Missouri.
Edams, J. B.......................I. C. R. R., Amboy, Illinois.
Evans, T............................C. & F. R. R., Catasauqua, Pennsylvania.
Erwin, J. H.......................S. F. Division L. R. R., Sheboygan, Wisconsin.
Eastman, J. U....................N. & C. R. R., Nashville, Tennessee.
Ellis, John C......................Schenectady Loco. Works, Schenectady, N. Y.
Eastman, C. L....................C. R. R., Concord, New Hampshire.
Freeman, W. G...................C. & O. R. R., Richmond, Virginia.
Foster, W. L......................P. & E. R. R., Renovo, Pennsylvania.
Fry, Howard.......................G. T. R. R., Sherbrook, Quebec, Canada.
Flynn, J. H........................W. & A. R. R., Atlanta, Georgia.
Fuller, Wm.........................A. & G. W. R. R., Meadville, Pennsylvania.
Foss, J. M..........................V. C. R. R., St. Albans, Vermont.
Gibbs, E. B.........................P. of M. R. R., St. Louis, Missouri.
Graham, C..........................L. & B. R. R., Kingston, Pennsylvania.

ayle, J. B.......................R. & G. R. R., Raleigh, North Carolina.
lass, G. W.......................A. V. R. R., Pittsburgh, Pennsylvania.
arfield, E.......................H. P. & F. R. R., Hartford, Connecticut.
arrett, H. D.......................P. R. R., West Philadelphia, Pennsylvania.
regg, J. B.......................Erie R. R., Susquehanna, Pennsylvania.
orman, T. G.......................T. W. & W. R. R., Springfield, Illinois.
riggs, W. H.......................N. Y. & O. M. R. R., Oswego, New York.
rant, R. D.......................Late C. R. I. & St. L. R. R., Bardstown, Ill.
riggs, Albert.......................W. & N. R. R., Worcester, Massachusetts.
ranger, W. E.......................W. & B. R. R. R., Utica, New York.
riggs, G. H.......................F. & N. S. R. R., College Point, Long Island.
ay, Robt.......................M. P. R. R., Mineral Point, Wisconsin.
ays, S. J.......................Ill. Cent. R. R., Chicago, Illinois.
ill, E. O.......................Erie R. R., New York.
olloway, J. W.......................C. Mt. V. & D. R. R., Akron, Ohio.
am, C. T.......................Kelley's Lamp Works, Rochester, New York.
ayes, N.......................W. & O. R. R., Alexandria, Virginia.
ull, A. S.......................C. V. R. R., Chambersburg, Pennsylvania.
ofecker, P.......................L. V. R. R., Weatherby, Pennsylvania.
udson, W. S.......................Rogers' Locomotive Works, Paterson, N. J.
ibberd, A. W.......................Jefferson City Iron Works, Jefferson City, Mo.
ewitt, John.......................A. & P. R. R., Franklin, Missouri.
alle, Geo.......................W. C. & A. R. R., Wilmington, N. C.
aynes, O. A.......................St. L. & I. M. R. R., Carondelet, Missouri.
ealy, B. W.......................Locomotive Works, Providence, R. I.
udson, J. M.......................Gen'l For. L. M. R. R., Cincinnati, Ohio.
rdon, W. L.......................C. & P. R. R., Mt. Savage, Maryland.
hann, J.......................615 Jefferson Avenue, St. Louis, Missouri.
uriet, C. F.......................C. B. & Q. R. R., Aurora, Illinois.
ckson, Wm.......................R. W. & O. R. R., Rome, New York.
ckman, J. A.......................C. A. & St. L. R. R., Bloomington, Illinois.
ones, Thos.......................C. & F. R. R., Catasauque, Pennsylvania.
insey, J. I.......................L. V. R. R., Easton, Pennsylvania.
elley, J.......................P. & W. R. R., Providence, Rhode Island.
Keenan, A. J.......................D. & U. R. R., Dayton, Ohio.
Kerr, Thos.......................C. & A. R. R., Bordentown, New Jersey.
Keeler S.......................F. & P. M. R. R., East Saginaw, Michigan.
Kline, T. D.......................S. & M. R. R., Opelica, Alabama.
Kidder, B. H.......................B. E. L. S. & M. S. R. R., Buffalo, New York.
Little, H. A.......................2043 Tower Street, Philadelphia, Pa.
Little, O. H. P.......................Indianapolis, Indiana.
osey, J.......................L. N. A. & C. R. R., New Albany, Indiana.
osee, T. N.......................P. C. & St. L. R. R., Indianapolis, Indiana.

Lewis, C. M	N. C. R. R., Baltimore, Maryland.
Lauder, J. N	N. R. R., Concord, New Hampshire.
Lincoln, H. A	S. L. R. R., New Haven, Connecticut.
Leech, H. L	Boston Locomotive Works, Boston, Mass.
Lamb, J	D. M. V. R. R., Keokuk, Iowa.
Logan, P. A	E. & N. A. R. R., Fairchild, New Brunswick.
Moore, S	P. Ft. W. & C. R. R., Allegheny, Pennsylvania.
Mulligan, J	C. R. R. R., Springfield, Massachusetts.
Meier, E. D	100 Main Street, St. Louis, Missouri.
Marston, C. O	I. C. & L. R. R., Indianapolis, Indiana.
Mullin, James	W. & A. R. R., Atlanta, Georgia.
Mullin, James, Jr	W. & A. R. R., Atlanta, Georgia.
Mitchell, A	L. V. R. R., Mauch Chunk, Pennsylvania.
Montgomery, James	L. & N. R. R., Bowling Green, Kentucky.
Morse, G. F	Portland Locomotive Works, Portland, Maine.
Messer, J. P	B. C. R. & M. R. R., Cedar Rapids, Iowa.
Maynes, A. G	S. R. & D. R. R., Selma, Alabama.
McElroy, J	O. C. & A. R. R., Corry, Pennsylvania.
McDowell, R	R. D. R. R., Lambertville, New Jersey.
McKenna, J	I. P. & C. R. R., Peru, Indiana.
McAllister, W	W. J. R. R., Camden, New Jersey.
McFarland, Jas	M. & M. R. R., Montgomery, Alabama.
McFarland, John	R. & D. R. R., Richmond, Virginia.
McCrum, J. S	M. R. Ft. S. & G. R. R., Kansas City, Missouri.
McCann, James	M. & W. P. R. R., Montgomery, Alabama.
McVay, John	W. R. R. of A. R. R., Montgomery, Alabama.
Marsh, E. H	W. N. C. R. R., Salisbury, North Carolina.
Martin, J. W	G. T. R. R., Portland, Maine.
Nesbitt, J. W	E. T. H. & C. R. R., Terre Haute, Indiana.
Noyes, Warren	G. T. Eastern Division, Canada.
Pendleton, J. B	S. & R. R. R., Portsmouth, Virginia.
Philbrick, J. W	M. C. R. R., Waterville, Maine.
Perry, F. A	C. & A. R. R., Keene, New Hampshire.
Perry, G. W	P. W. & B. R. R., Wilmington, Delaware.
Pierce, E	P. C. & S. L. R. R., Dennison, Ohio.
Palmer, E. D	P. C. & St. L. R. R., Richmond, Indiana.
Parks, W. M	T. B. R. R., Taunton, Massachusetts.
Philbrick, S. M	L. L. & G. R. R., Lawrence, Kansas.
Perkins, E. F	Taunton, Massachuseetts.
Perrin, P. J	Taunton Locomotive Works, Taunton, Mass.
Prescott, A. J	C. R. R., Catawissa, Pennsylvania.
Peeples, T. W	C. of N. J. R. R., Elizabethport, New Jersey.
Peddle, J. R	St. L. V. & T. H. R. R., Terre Haute, Indiana.

Ray, W. F.........................T. W. & W. R. R., Fort Wayne, Indiana.
Richards, G. B.........................G. B. & P. R. R., Boston Highlands, Mass.
Rennie, D. P.........................P. & C. R. R., Pittsburgh, Pennsylvania.
Roop, F.........................N. P. R. R., Philadelphia, Pennsylvania.
Robinson, W. A.........................G. W. R. R., Hamilton, Canada West.
Robinette, J. T.........................S. S. R. R., Petersburgh, Virginia.
Rowley, W. D.........................U. P. R. R., Atchison, Iowa.
Somers, A. H.........................P. Ft. W. & C. R. R., Valparaiso, Indiana.
Skidmore, J.........................L. C. & L. R. R., Louisville, Kentucky.
Shaver, D. O.........................Pennsylvania R. R., Pittsburgh, Pennsylvania.
Smith, W. F.........................C. C. C. & I. R. R., Cleveland, Ohio.
Sellers, Morris.........................Air Brake Company, Pittsburgh, Pennsylvania.
Setchel, J. H.........................L. M. R. R., Cincinnati, Ohio.
Sellers, L. H.........................N. O. J. & G. N. R. R., New Orleans, La.
Smith, W. T.........................P. & E. R. R., Erie, Pennsylvania.
Sedgley, J.........................L. S. & M. S. R. R., Cleveland, Ohio.
Street, C. B.........................Pennsylvania R. R., Blairsville, Pennsylvania.
Strong, W. M.........................N. Y. & H. R. R., New York.
Studley, E.........................Late of C. R. R., Concord, New Hampshire.
Sanborn, A. J.........................St. L. V. & T. H. R. R., Effingham, Ill.
Stearns, W. H.........................C. R. R., Springfield, Massachusetts.
Sterk, F.........................V. & T. A. M. & O. Div., Lynchburg, Virginia.
Smith, J. T.........................Locomotive Builder, Pittsburgh, Pennsylvania.
Stewart, C. E.........................Panama R. R., 59 Wall Street, New York.
Stewart, R. C.........................P. H. & L. M. R. R., Port Huron, Michigan.
Smith, W. B.........................S. C. R. R., Charleston, South Carolina.
Sprague, H. N.........................Pittsburgh, Pennsylvania.
Tier, G. H.........................Toledo Division L. S. & M. S. R. R., Norwalk, O
Towne, L. N.........................H. & St. J. R. L., Hannibal, Missouri.
Thompson, C. A.........................L. I. R. R., Hunter's Point, L. I.
Thompson, J.........................P. Ft. W. & C. R. R., Crestline, Ohio.
Thompson, John.........................Eastern R. R., East Boston, Massachusetts.
Turreff, W. F.........................C. & P. R. R., Cleveland, Ohio.
Thompson, E.........................S. M. R. R., Hokah, Minnesota.
Taylor, J. K.........................O. C. & N. R. R., Boston, Massachusetts.
Taylor, E.........................Late N. M. R. R., St. Charles, Missouri.
Thornton, M.........................M. & B. R. R., Macon, Georgia.
Templeton, T. G.........................P. R. R., Battle Creek, Michigan.
Towne, H. A.........................H. & St. J. R. R., Hannibal, Missouri.
Thompson, A.........................O. & M. R. R., Vincennes, Indiana.
Tull, C. H.........................N. L. & T. R. R., Monroe, Louisiana.
Underhill, A. B.........................B. & A. R. R., Boston, Massachusetts.
Van Vetchen, J.........................A. & G. W. R. R., Meadville, Pennsylvania.

Van Tuyl, A	Urbana, Champaigne County, Illinois.
Van Buskirk	D. & C. R. R., Fishkill, New York.
Wells, R	J. M. & I. R. R., Jeffersonville, Indiana
Wright, N	A. & G. W. R. R., Kent, Ohio.
Whitney, H. A	E. & N. A. R. R., St. Johns, N. B.
Wade, R. D	N. C. R. R., Company's Shops, N. C.
Wiggin, J. E	B. H. & E. R. R., Boston, Massachusetts
Waite, F. A	B. & M. R. R., Boston, Massachusetts.
Woodcock, W	P. G. & N. R. R., Philadelphia, Pennsy
White, J. L	E. & C. R. R., Evansville, Indiana.
Waddy, J. E	O. A. & M. R R., Alexandria, Virginia
Walker, E. A	C. C. R. R., Hyannis, Massachusetts.
Williams, E. H	Baird & Co., Loco. Builders, Philadelpl
Wooten, J. E	P. & R. R. R., Reading, Pennsylvania.
Waugh, L. H	K. P. R. R., Wyandotte, Kansas.
Weaver, D. S	E. K. R. R., Riverton, Kentucky.
Whitworth, J. S	I. S. N. & P. R. R., Norfolk, Virginia.
Wood, M. P	C. & T. H. R. R., Cincinnati, Ohio.
Young, L. S	C. C. C. & I. R. R., Cleveland, Ohio.
Young, John	E. & P. R. R., Erie Pennsylvania.

ASSOCIATE MEMBERS.

Bement, W. B	21st and Callowell Street, Philadelphi
Evans, W. W	45 & 47 Exchange Place, New York.
Forney, M. N	Railway Gazette, 72 Broadway, New
Holly, A. F	Troy, New York.
Lilly, J. O. D	Indianapolis, Indiana.
Miles, F. B	Ferris & Miles, Philadelphia, Penn
Morton, Henry	Hoboken, New Jersey.
Nott, Gordon H	Boston, Massachusetts.
Sellers, Coleman	Philadelphia, Pennsylvania.
Smith, J. Laurence	Louisville, Kentucky.
Thurston, R. H	Hoboken, New Jersey.
Wheelock, James	Worcester, Massachusetts.

CINCINNATI, October 29, 1872.

To the American Railway Master Mechanics' Association:

GENTLEMEN—It is with great pleasure the General Supervisory Committee lays before you the subjoined correspondence, which has taken place since the close of our last annual meeting.

It is full of meaning for the future wellfare of our Association, and places within its power the means of offering a liberal premium to those possessed of mechanical skill and genius to seek and study out some of those vexed questions which so deeply interest master mechanics and railway officials.

For this, as well as the many other courtesies freely and bountifully bestowed on this Association at its last annual meeting, you are indebted to the good people of Boston.

For the Committee,

J. H. SETCHEL, *Secretary.*

BOSTON, July 2, 1872.

H. M. BRITTON, Esq., *President American Railway Master Mechanics' Association:*

DEAR SIR—At a meeting of the subscribers to the fund for the entertainment of your Association during its recent visit to Boston, a balance was found to be left in the Treasurer's hands.

By a unanimous vote of the subscribers the Finance Committee were directed to apply the amount to the benefit of the Master Mechanics' Association in whatever manner they might see fit.

Accordingly the Finance Committee have directed me, as Treasurer, to ask your acceptance of the inclosed draft for three thousand dollars, to be placed in the hands of three trustees (chosen by the Association) and used for the benefit of the Association in such manner as the trustees may direct.

I remain, dear sir, very respectfully yours,

F. A. HOWARD, *Treasurer.*

CINCINNATI, July 19, 1872.

F. A. HOWARD, Esq., *Treasurer, Boston, Mass.*

DEAR SIR—Your favor of July 2, inclosing draft for three thousand dollars ($3,000) to be placed in the hands of trustees for the benefit ot the American Railway Master Mechanics Association is received.

By advice of the General Supervisory Committee I have placed the same

at interest until May, 1873, when our Association meets at Baltimore. Trustees will then be appointed to take charge of the fund, as per direction of your letter.

In behalf of our Association I would express to your Committee our sincere thanks for their magnificent gift. I trust it will be used in a manner to meet their approval, and not cause them to regret its bestowal.

Renewing our expression of thanks,

I am very truly yours,

H. M. BRITTON, *President.*

ORDER OF BUSINESS.

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1. Reading the minutes of previous meeting.
2. Calling the Roll of Members.
3. Signing the Constitution.
4. Report of Treasurer.
5. Report of Committees appointed at a previous meeting.
6. Election of Officers.
7. Appointment of a Committee to suggest Subjects for Consideration.
8. Appointment of Miscellaneous Committees; on Finance, Printing, place for next Annual Meeting, etc.
9. Report of Committee to suggest Subjects for Consideration.
10. Appointment of Committees to report upon the Subjects suggested for Consideration.
11. Unfinished Business.

Signed,

H. M. BRITTON,
N. E. CHAPMAN,
J. H. SETCHEL,
Committee.

INDEX.

THE

SIXTH ANNUAL REPORT

OF THE

AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION,

IN CONVENTION AT

BALTIMORE, MAY 13TH, 14TH, AND 15TH, 1873.

CINCINNATI:
WILSTACH, BALDWIN & CO.,
RAILWAY PRINTERS AND MANUFACTURING STATIONERS,
Nos. 141 AND 143 RACE STREET.
1873.

AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION,

OFFICERS FOR 1873.

PRESIDENT,

H. M. BRITTON, of Cincinnati.

FIRST VICE-PRESIDENT,

N. E. CHAPMAN, of Cleveland.

SECOND VICE-PRESIDENT,

W. A. ROBINSON, of Canada West.

TREASURER,

S. J. HAYES, of Chicago.

SECRETARY.

J. H. SETCHEL, of Cincinnati.

REPORT.

he Sixth Annual Session of the American Railway Master Meiics' Association convened at Raines' Hall, Baltimore, Maryland, 13th, 1873.

SIDENT H. M. BRITTON, of White Water Valley R. R., in the chair.
E. CHAPMAN, Cleveland & Pittsburgh R. R., 1ST VICE-PRESIDENT.
[. SETCHEL, Little Miami R. R., SECRETARY.

he Session was opened at 9 o'clock A. M. with prayer by the Rev. Mr. htbourne, of Baltimore; after which the first business being the reading of minutes of the last annual meeting, they were, on motion of Mr. Eddy, Boston & Albany Railroad, approved without reading.

he roll of members was then called by the Secretary, by which the folng named gentlemen were found to be present:

NAME.	ROAD.	ADDRESS.
NDERSON	Chicago & North-Western	Chicago, Ill.
. BRITTON	White Water Valley	Cincinnati, O.
. BROWN	Erie	New York City.
. BOONE	Pittsburgh, Fort Wayne & Chicago	Fort Wayne, Ind.
. BURROUGHS	Marquette & Ontonagon	Marquette, Mich.
. BOYDEN	Boston, Hartford & Erie	Boston, Mass.
. BROOKS	Brooks' Locomotive Works	Dunkirk, N. Y.
. CHAPMAN	Cleveland & Pittsburgh	Cleveland, O.
. CUMMINGS	Pittsburgh, Fort Wayne & Chicago	Allegheny, Pa.
. COOPER	Erie	Hornersville, N. Y.
. COOPER	Kansas City, St. Joseph & Council Bluffs	Kansas City, Mo.
LARK	Lehigh Valley	Hazleton, Pa.
DURGIN	Pittsburgh Locomotive Works	Pittsburgh, Pa.
SON EDDY	Boston & Albany	Springfield, Mass.

NAME.	ROAD.	ADDRESS.
HARRY ELLIOTT	Ohio & Mississippi	East St. Louis,
T. EVANS	Catasauqua & Foglesville	Catasauqua, Pa
HOWARD FRY	Erie	New York City
J. H. FLYNN	Western & Atlantic	Atlanta, Ga.
C. GRAHAM	Lackawanna & Bloomsburg	Kingston, Pa.
J. B. GAYLE	Raleigh & Gaston	Raleigh, N. C.
G. W. GLASS	Allegheny Valley	Pittsburgh, Pa.
E. GARFIELD	Hartford, Providence & Fishkill	Hartford, Conn
T. G. GORMAN	Toledo, Wabash & Western	Springfield, Ill.
C. T. HAM	Kelly's Lamp Works	Rochester, N. Y
A. S. HULL	Cumberland Valley	Chambersburg,
W. S. HUDSON	Rogers' Locomotive Works	Paterson, N. J.
B. W. HEALY	Rhode Island Locomotive Works	Providence, R.
W. L. JORDON	Cumberland & Pennsylvania	Mt. Savage, Md
THOS, JONES	Catasauqua & Foglesville	Catasauqua, Pa
J. I. KINSEY	Lehigh Valley	Easton, Pa.
THOS. KERR	Camden & Amboy	Bordentown, N
S. KEELER	Flint & Pere Marquette	East Saginaw,
H. A. LITTLE	2043 Tower Street	Philadelphia, P
O. H. P. LITTLE		Indianapolis, In
C. M. LEWIS	Northern Central	Baltimore, Md.
H. A. LINCOLN	Shore Line	New Haven, Co
J. LAMB	Des Moines Valley	Keokuk, Iowa.
J. P. MESSER	Burlington, Cedar Rapids & Minnesota	Cedar Rapids, Io
R. McDOWELL	Belvidere, Delaware	Lambertville, N
W. McALLISTER	West Jersey	Camden, N. J.
JOHN McFARLAND	Richmond & Danville	Richmond, Va.
J. W. PHILBRICK	Maine Central	Waterville, Mai
G. W. PERRY	Late Phila., Wilmington & Baltimore	Wilmington, De
A. J. PRESCOTT	Catawissa	Catawissa, Pa.
T. W. PEEPLES	Central of New Jersey	Elizabethport,
G. B. RICHARDS	Boston & Providence	Bos. Highlands,
W. A. ROBINSON	Great Western	Hamilton, Can
D. O. SHAVER	Pennsylvania	Pittsburgh, Pa.
J. H. SETCHEL	Little Miami	Cincinnati, O.
C. B. STREET	Pennsylvania	Blairsville, Pa.
W. M. STRONG	New York & Harlem	New York City.
A. J. SANBORN	St. Louis, Vandalia & Terre Haute	Effingham, Ill.
W. H. STEARNS	Connecticut River	Springfield, Mas
W. B. SMITH	South Carolina	Charleston, S. C
H. TIER	Toledo Div. Lake Shore & Mich. Southern	Norwalk, O.
JOHN THOMPSON	Eastern	East Boston, M
W. F. TURREFF	Cleveland & Pittsburgh	Cleveland, O.
J. K. TAYLOR	Old Colony & Newport	Boston, Mass.

NAME.	ROAD.	ADDRESS.
C. H. TULL	North Louisiana & Texas	Monroe, La.
A. B. UNDERHILL	Boston & Albany	Boston, Mass.
J VAN VETCHEN	Erie	Jersey City, N. J.
W. G. VAN BUSKIRK	Dutchess & Columbia	Fishkill, N. Y.
H. A. WHITNEY	European & North American	St. Johns, N. B.
R. D. WADE	North Carolina	Company Shop, N. C.
F. A. WAITE	Boston & Maine	Boston, Mass.
W. WOODCOCK	Central Railroad of New Jersey	Elizabethport, N. J.
J. L. WHITE	Evansville & Crawfordsville	Evansville, Ind.
J. E. WADDY	Orange, Alexandria & Manassas	Alexandria, Va.
E. H. WILLIAMS	Baird & Co., Locomotive Builders	Philadelphia, Pa.
J. E. WOOTEN	Philadelphia & Reading	Reading, Pa.

ASSOCIATE MEMBERS PRESENT.

NAME.	ROAD.	ADDRESS.
W. B. BEMENT	Twenty-first and Callowhill Streets	Philadelphia, Pa.
M. N. FORNEY	Railway Gazette	73 Broadway, N. Y.
J. O. D. LILLY		Indianapolis, Ind.
F. B. MILES	Ferris & Miles	Philadelphia, Pa.
COLEMAN SELLERS		Philadelphia, Pa.
J. WHEELOCK		Worcester, Mass.

The Secretary then read the Article of the Constitution in relation to membership, and the President extended a cordial invitation to all Master Mechanics present who were not members to join the Association.

The following gentlemen then came forward and signed the Constitution:

NAME.	ROAD.	ADDRESS.
W. H. LEWIS	Morris & Essex Div. Del., Lack. & Wes'n.	Hoboken, N. J.
N. SLINGLAND	Connecticut Western	Hartford, Conn.
C. W. HOLLISTER	Connecticut Valley	Hartford, Conn.
F. C. LOSEY	Michigan Central	Jackson, Mich.
C. C. ELLIOTT	Iowa Div. Chicago & North-west	Calverton, Iowa.
ROBERT KING	Charlotte, Columbia & Augusta	Charlotte, N. C.
THOS. B. PURVES	Western Div. Boston & Albany	Greenler, N. Y.
C. H. BROWN	Utica Div. Delaware, Lackawanna & West.	Utica, N. Y.
JOSEPH ELDER	Rockford, Rock Island & St. Louis	Bardstown, Ill.

NAME.	ROAD.	ADDRESS.
HENRY HANFORD	Naugatuck	Bridgeport, Conn.
JOHN F. CROCKETT	Boston, Lowell & Nashua	Boston, Mass.
A. GOULD	New York Central & Hudson River	Rochester, N. Y.
J. F. SECHLER	New York & Oswego Midland	Wortendyke, N. J.
PETER CLARKE	Northern Railroad of Canada	Toronto, Canada.
EZRA OSBORN	Grant Locomotive Works	Paterson, N. J.
J. G. HUBBARD	Erie	Buffalo, N. Y.
WM. H. ELLIS	Catawissa	Catawissa, Pa.
THOS. LINGLE	Pennsylvania	South Amboy, N. J.
G. H. PRESCOTT	Pittsburgh, Cincinnati & St. Louis	Logansport, Ind.
J. M. BLANCHARD	Seaboard & Roanoke	Portsmouth, Va.
WM. LANNAN	West Maryland	Union Bridge, Md.
F. GOULD	Missouri, Kansas & Texas	Sedalia, Mo.
L. O. GASSETT	Lake Shore & Michigan Southern	South Cleveland, O.
MARTIN WALLS	Philadelphia & Erie	Sunbury, Pa.
SAMUEL STEINBERGER	Jeffersonville, Madison & Indianapolis	Madison, Ind.
R. V. DOHONEY	West Maryland	Westminster, Md.

The President then delivered his annual address:

PRESIDENT'S ADDRESS.

Gentlemen of the American Railway Master Mechanics' Association: I congratulate you upon our Sixth Anniversary—I congratulate you that each succeeding year gives new evidences of the prosperity of our Association, for that is a sure guaranty of its great utility. Created by the necessities of a great, increasing, and limitless industry, it aims to be worthy of the causes which gave it birth.

The age in which we live, fruitful as it has been in great events, wonderful changes and great accomplishments, is pre-eminently distinguished for the progress which has been made in the mechanical arts.

In many branches of mechanics, however, the wonderful relics of the ingenuity, industry, and ability of past ages leave this period nothing of which to boast. The silent Egyptian Pyramids and the animated relics of Grecian and Roman art still remain unequalled; but it has been reserved for this age to far surpass all that have pre-

ceded it in the great work to which you have devoted your energies and your lives.

No dreamer in the most remote or nearest past ever pictured to the imagination the effect which has been produced by the iron bands which now stretch in every direction over two continents, with the machinery moving upon them of which you in America are the representatives. Such thoughts naturally suggest to you the magnitude of your duties and responsibilities.

Where the progress has been so great, more is naturally expected. Where so much that was deemed impossible has been done, there is danger that what is impossible will be expected. The great danger, to-day, is that more will be expected of railroad machinery than it can perform. There is a limit, beyond which it is not possible to safely or economically operate machinery. The present state of public feeling in many parts of the country, aroused from the fact that producers, both manufacturers and farmers, find that their products can not be delivered at great distances so as to be sold at a large profit, is the result of a want of proper general information upon the possibility of moving great bulks considerable distances by the machinery which you represent.

It is for us to do our part to enlighten the public on this subject. How can we better accomplish this than to meet in convention once each year, select subjects, appoint committees to compile reports, and then enter into an open discussion of them.

The reports last year were very satisfactory, and a credit to the committees who compiled them. The discussions which followed were by far the best we have had at our meetings. Let us continue to excel in our reports and discussions.

Great credit is due your Secretary for the manner in which he has performed the duties of his office the past year. He has been untiring in his efforts to promote the welfare of our Associaton.

Some of our members complain that their superior officers object to their attending our convention; also some object to paying their expenses. If such members will present their President and Superintendent with our printed reports, and request that they read our proceedings, I am confident they will be convinced it is for their interest that their Master Mechanic should attend our meetings.

After the adjournment of the last annual meeting, this Association was presented, through its President, with three thousand dollars ($3,000) by the Committee who entertained us while in the city of Boston. Your Supervisory Committee placed the amount on interest subject to the action of the Association. I would recommend that trustees be appointed to take charge of this money as per request of the donors.

Gentlemen, the recollection of our former meetings in the West and in the East, have for every one of us something distinctly agreeable of the locality at which they occurred, and I am sure that all of you are glad that to-day we meet in the city of Baltimore.

Its localities have great general interest to all of us, quite sufficient to make us rejoice to be here. But beyond that our professional interest can not fail to receive the highest gratification.

From Baltimore radiate north, west, and south some of the most important railroad lines. Her connections are with every part of the country, and keep pace with what is most permanent in railroad enterprise and progress.

Gentlemen, rejoicing to meet every one of you, and wishing you all the pleasure and improvement that this reunion promises, I now invite you to enter upon the business of the Convention.

The President also stated that a number of invitations extending hospitalities to the Convention had been received, and suggested the appointment of a committee to consider the same.

Mr. Chapman, Cleveland & Pittsburgh Railroad, moved that a committee of three be appointed to consider and report on all the correspondence that might come before the convention.

The motion was carried, when the President appointed as the committee, Messrs. Chapman of the Cleveland & Pittsburgh Railroad, Robinson of the Great Western Railroad of Canada, and Flynn of the Western & Atlantic Railroad of Georgia.

President Britton—The next business in order will be the reading of the reports of your Secretary and Treasurer.

SECRETARY'S REPORT.

H. M. Britton, Esq., *President American Railway Master Mechanics' Association:*

Dear Sir—I herewith hand you my Official Report of Membership and Money received during the year ending May 13, 1873.

Within the past two years, eleven members of this Association have requested that their names be dropped from the list, viz.: Josiah Bettis, T. Denmead (since deceased), S. D. Danfield, G. H. Griggs, D. W. Haines, J. N. Moore, John Black, C. N. Parker, E. D. Palmer, W. Swanston, and E. A. Walker. Five of these have resigned on account of engaging in other business, two on account of not being able to pay their dues, one on account of not being able to attend the convention, and three have assigned *no* reason for withdrawing.

Since the last annual meeting seven members have joined the Association by paying the initiation fee of one dollar, and authorizing me, as Secretary, to sign the Constitution and By-laws for them, as provided for in Section 1, Article IV.

The total number of members at the present time is two hundred and twenty-two (222).

The total amount of money received during the past year is 2,067, for all of which I hold the Treasurer's receipts.

The total amount of assessment due the Association from delinquent members is $502.

Very respectfully,

J. H. SETCHEL, *Secretary.*

CHICAGO, MAY 10, 1873.

S. J. HAYES, Treasurer, in Account with

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

1872.		Dr.
June 11	To Balance on hand	$58 65
Oct. 5	" Secretary in Currency	500 00
" 5	" " " Vouchers	1,036 26
Nov. 15	" " " Currency, $71; Receipts, $30	101 00
Dec. 31	" " " Check	100 00
1873.		
Jan. 17	" " " Voucher	74 58
Mar. 8	" " " Check	71 00
April 11	" " " Voucher	39 25
" 11	" " " "	31 92
" 11	" " " Check	40 00
" 29	" " " Voucher	10 75
" 29	" " " Check	62 29
		$2,125 70

1872.			Cr.
June 11	By J. H. Setchel	Voucher No. 1	$61 26
" 13	" Mass. Horticultural Society	" " 2	165 00
" 13	" J. F. Cabot & Brother	" " 3	2 75
July 1	" Wilstach, Baldwin & Co.	" " 4	117 25
June 14	" J. H Setchel	" " 5	500 00
Sept. 30	" J. W. Yennington	" " 6	190 00
Dec. 31	" Wilstach, Baldwin & Co.	" " 7	707 50
1873.			
Jan. 4	" S. J. Hayes	" " 8	1 90
Mar. 13	" Wilstach, Baldwin & Co.	" " 9	100 80
1872.			
Dec. 30	" J. S. Morrison	" " 10	74 58
1873.			
Mar. 28	" Wilstach, Baldwin & Co.	" " 11	39 25
April 1	" J. H. Setchel	" " 12	31 92
" 11	" Wilstach, Baldwin & Co.	" " 13	10 75
	" Balance		122 74
			$2,125 70

Respectfully submitted,

S. J. HAYES, TREASURER.

On motion of Mr. Keeler of the Flint & Pere Marquette Railroad, the re- rts were received.

PRESIDENT BRITTON—The next business in order would be the Report of e Committee on Locomotive Boiler Construction, but that committee has iled to make any report as yet. Mr. Hayes, the chairman of the commit- , not being present, we shall have to postpone the report for the pres- t. The next business in order will be the Report of the Committee on the eration and Management of Locomotive Boilers, including the Purifi- ion of Water. The report is in the hands of the Secretary, who will d it.

port of Committee on Operation and Management of Locomotive Boilers, Including Purification of Water.

the American Railway Master Mechanics' Association:

GENTLEMEN—In submitting the following Report on the subject Boiler Incrustation and the Operation and Management of Loco- tive Boilers, including the Purification of Water, it would seem oper, first, in order to get at a clearer understanding of the subject d its difficulties, to make a brief review of former reports.

Before doing so, however, your Committee desire to say that there probably no subject of more importance to railroad and manufac- ing interests of the country than how to prevent the incrustation steam boilers. It not only causes great waste of fuel (estimated, understand, by French engineers at forty-five per cent. of the al amount consumed), but also by preventing the contact of the er with the iron, causing the metal to become greatly overheated, l thus rapidly burn out, making frequent repairs necessary, ides inviting boiler explosions, which may arise, not only from weakening of the metal itself, but also from the fact that the rheated plates may cause the scale to crack and fall off, allowing water to come in contact with intensely heated surfaces, thereby denly generating immense volumes of steam, which, being con- d, produce a concussion. According to the last annual re- t, fully twenty per cent. of the whole amount of fuel consumed onsidered due to the effects of bad water and incrustation *alone*, ich estimate is probably more nearly correct on roads in this ntry.

Your Committee, in their efforts to discover a remedy for this great evil, have heretofore been confined almost entirely to practical experiments and investigations, and if they failed to reach the desired object in this direction, it was more from the want of scientific knowledge than any lack of interest, as will be seen by reference to the last two reports to the Association.

Your Committee were unable to obtain a copy of the first annual report in time for any comment. The second report has an expression from twenty-three members of the Association, all varying more or less in their opinions as to the best method of preventing incrustation. They had all experimented with powders, fluids, batteries, etc., but the majority looked upon all such nostrums with suspicion, believing them more or less injurious to boilers and dangerous auxiliaries.

This opinion is supported by the Committee, who seem unwilling to accept any of the so-called remedies which are thrown upon the market for this purpose, and conclude by recommending thorough and frequent washing as the best and most reliable cure.

The third report on this subject consisted of a letter from one of the Committee, submitting briefly his own opinion, with little or no investigation of the matter.

The fourth report contains a more general expression from members of the Association, a large number of them giving their opinions and experience at length, which may be taken as the most reliable information concerning some of the great difficulties and expense attending the use of waters which form scale in steam boilers.

In this report, as well as in former ones, the use of "compounds" for removing incrustation is not recommended, the Committee believing the only effectual remedy being to purify the water before it is allowed to enter the boiler; and they dwell at considerable length on various plans for the accomplishment of this purpose. For want of a trial of the plan suggested they were unable to arrive at any positive proof as to its efficacy or practicability, hence the subject was left unexplored as before.

The fifth and last annual report enters into a long, detailed, and exhaustive statement as to the cost of purifying water by the process

of boiling, assuming from data, which may be seen in the report, that boiling under pressure would precipitate at least a portion of the impurities contained in the water; and, for want of something more reliable to offer, the Committee proceeded with an analysis of the subject before them, stating very clearly and quite accurately the expense attending the use of impure water in locomotive boilers, also comparative cost of boiler repairs and the extra cost of fuel due to the above causes.

The report as a whole, though it does not provide a remedy, contains some valuable information, and the discussion it provoked has led to the development of facts which might not have been reached had it been less suggestive.

It will be seen from the beginning that the Committee have not departed from their first conclusions in reference to purifying the water before it is taken into the boiler, and it was only with this object in view that they entered into the detail of the last report. In the course of the discussion before the Convention, it was stated that pure or distilled water was injurious to boilers, but we conclude from the remarks that they referred only to distilled sea water, for the reason that we know of no place where distilled water is used for this purpose except on ocean steamers, where it is said to be quite destructive to boilers. No positive reason was, however, assigned for the deteriorating effect of distilled (sea) water on iron, only that it was known to have been the result of the use of such water.

The word "pure" in this case is based on the assumption that any water distilled or evaporated, and afterwards reconverted into water, must necessarily be pure—which is a fact, perhaps, with fresh water, but not so with sea water, as will be seen by reference to the following analysis of both.

Your Committee, desiring to obtain the facts in this case, procured, through the kindness of Mr. John Thompson, of the Eastern Railroad, a specimen of sea water from a point near Minot's Ledge, off the Bay of Boston, and under the personal supervision of the Chairman of the Committee, several gallons of this water were carefully evaporated, in an apparatus arranged for the purpose, and the vapor, or steam, at a pressure of 60 pounds to the square inch, was condensed or reconverted into water. A specimen of the distilled (sea

water was then sent to Prof. J. A. Sewall, of Normal University, Ills., for analysis, and it was found to contain a portion of hydrochloric acid, thus showing that, in the process of distilling or condensing the vapor of sea water, hydrochloric acid passes over with the steam, and is incorporated with the water used in boilers at sea; and whenever this water is used in connection with the distilled (sea) water, it approaches more nearly the combination of chlorine gas, which is very destructive to metals. According to Chemistry, by John A. Porter, M. A. M. D., "Nascent chlorine, in its action on the metals, is the most powerful agent known. Even the noble metals yield to its power, and waste away in the liquid which contains it. The term *nascent* signifies being born, or in the act of formation, or escape from a previous combination." "All gases are most energetic in their action at the first moment of their separation from compounds which contain them, and, while they may be regarded as still retaining the solid form themselves, the subsequent expansion into the gaseous form diminishes their energy."

The process of condensation leaves, according to the following analysis, only a trace of hydrochloric acid, which, in itself, is sufficiently powerful to dissolve tin, iron, and other similar metals, and hence the rapid deterioration of boilers using distilled sea water.

It has been asserted, and it is still believed by some, that distilled fresh water is also injurious to boilers. Your Committee, being somewhat in doubt as to the truth of this statement, were determined to ascertain the chemical properties of such water, and thereby learn, if possible, its effect upon boilers. (Any water, whether pure or not, will cause oxidation wherever it comes in contact with the fibers of the iron, and the rapid corrosion of furrows adjacent to lap-joints may be due to this cause, as the constant alternate bending and rebending of the plates, by expansion and contraction, must gradually loosen the texture of the metal, and expose it to the attack of the water.)

It was also desirable to have an analysis of water that had been boiled under pressure.

They accordingly took a specimen of water from the wells that supply the shops of the Hannibal & St. Joseph Railroad, at Hannibal, and boiled it, under a pressure of fifteen pounds, for several

ter which they allowed it twenty-four hours to cool and set- part of it was drawn off from the top without agitating the and a specimen preserved for analysis. A like quantity from the wells at the same time, which was also retained me purpose. Another specimen (No. 3) of the same water ise preserved, after being distilled or rather condensed in sing apparatus now employed at the above shops for the of condensing the steam from the engine, and thus using over and over again for the supply of the boilers. This was patented by Messrs. Covington & Draper, and after- sued, covering important improvements, by H. A. Towne. enser has been in constant use for nearly six months, and es fully eighty (80) per cent. of condensed water. With- er comment on the merits of this improvement, your Com- uld call the attention of the Convention to the analysis of (4) specimens of water—No. 1, as taken from the wells in l state; No. 2, after being boiled as before described; No. n from the condenser; and No. 4, the distilled sea water:

of Four Specimens of Water sent me by H. A. Towne, Hannibal, Mo.

No. 1.

sodium, 9.162 grains in a gallon, or .01553 per cent.
te lime, 7.103 grains in a gallon, or .01203 per cent.
te magnesia, 3.027 grains in a gallon, or .00513 per cent.
e lime, alumina, lithia, a trace of each.

No. 2.

sodium. 9.087 grains in a gallon, or .01540 per cent.
te lime, 5.532 grains in a gallon, or .00937 per cent.
te magnesia, 3.017 grains in a gallon, or .00511 per cent.
lime, a trace.
and lithia not sought or looked for; probably a trace, as in No. 1.

No. 3.

ide of iron, .321 grains in a gallon, or .00054 per cent.

No. 4.

Examined only qualitatively. I found hcl., or hydrochloric, acid (a trace).

I certify that the above analyses are correct.

JOSEPH A. SEWALL, M. D,

Professor of Chemistry, Illinois State University.

NORMAL, March 4, 1873.

It will be observed that No. 1 contains a large proportion of chloride sodium, carbonate lime, carbonate magnesia, etc. No. 2 contains the same ingredients in slightly diminished quantities, its treatment having simply precipitated only an appreciable quantity of carbonate lime, clearly showing that boiling alone, under a pressure of fifteen (15) pounds to the square inch, for a short length of time, will not precipitate any considerable quantity of the impurities. Hence we may conclude that boiling can not be made a practicable process of purifying water for steam boilers. According to the Chemistry before referred to: "Carbonate of lime dissolved in carbonate water is again precipitated on boiling the solution. This is owing to the escape of the acid. Incrustation in tea kettles and steam boilers in limestone districts owe their origin to the same cause. In some cases the crust is formed of gypsum or other earthy matter contained in the water. One method of avoiding this inconvenience in steam boilers is by the addition of a smaller boiler, in which the water is first heated and its sediment deposited." From the above it may be inferred that continuous boiling will precipitate carbonate of lime, etc., but the expense attending such a process would entirely preclude the possibiiity of its being practical. It would seem, then, that the question as to the matter of purifying water for steam boilers by the process of boiling may here be conclusively settled. No. 3, the distilled water from the condenser, as per analysis, contains only a trace of sesquioxide of iron, the presence of which may be owing to the probability that the condensed water oxidizes, and dissolves a quantity of the iron to which it is exposed in passing through the steam pipes, cylinder of the engine, and condenser. But the small quantity of iron in the distilled water can not be regarded particularly injurious to boilers; on the con

trary, we see no reason why it should not be a benefit than otherwise.

A brief description of the condenser and its advantages may not at this time be uninteresting. It is made of galvanized iron, of scroll or coil shape, or any other form by which the largest amount of condensing surface may be obtained within a given capacity. The condenser is placed inside of a tub arranged to receive it, and connected by pipe with the exhaust from the engine, into which the exhaust steam passes and is condensed by means of a sufficient supply of cold water surrounding the condenser, furnished through pipe *D*, and discharged from the top of the tub through pipe *F F*, flowing back to the well or source of supply. If desired, the water may be allowed to flow through coil pipe *H* within the heater, *G*, Figure 4; thence, through pipes arranged for warming buildings, on its course to the well. Figure 2 represents a tub containing the distilled water, from which the boilers are supplied, first passing through pipe *M* into the heater or drum, *G*; thence it is forced into the boilers through pipe *N* by means of an ordinary feed-water pump. It will be seen that the condenser and lower tub, Figure 2, are connected by means of a pipe, *O*, through which the distilled water from the condenser passes to said tub. Pipe *P*, Figure 1, is a necessary auxiliary, communicating the condenser with the open air (to prevent back pressure on the engine), and which may be extended to any desired height to facilitate the condensing qualities of the apparatus. This pipe is, if desired, fitted with a valve, *T*, for the purpose of forcing the uncondensed exhaust down into the lower tub through pipe *O*. Pipe *R* is used to make up the deficiency of feed water that may not be supplied by the condenser. Figure 3 represents the top or isometrical view of the tub and condensing apparatus, showing its scroll shape, together with the connecting pipes as seen in No. 1.

The whole arrangement rests on suitable framework, as seen in the tracing.

There is combined in this improvement all the advantages of any heater in the matter of supplying the boilers with hot feed water, besides furnishing from 80 to 90 per cent. of pure water, as shown the analysis of No. 3. (It is thought by some, as before stated,

that absolutely pure water is injurious to boilers. It is quite probable, however, that their inferences are drawn from the deleterious effects of distilled sea water, and not from any known results from the use of distilled fresh water.) But if this should be true, the introduction of from 10 to 20 per cent. of the natural water would forestall any objection to the condenser on this score.

This apparatus is only applicable to stationary and steamboat engines, and, while it has thus far proven to be the best invention for this purpose we have ever seen, it does not obviate the difficulty in this direction with the locomotive. The expense of converting water into steam, and condensing it for locomotive use, at watering stations, would be entirely too great, and your Committee has quite exhausted the subject in attempting to devise means for supplying locomotive boilers with pure water by any mechanical appliances. Several members of the Association recommend the storing of rain water in reservoirs, while others do not believe it practicable on account of the expense of such a practice. But in the absence of any other remedy, or the probability of ever finding one, your Committee are inclined to favor it.

By reference to the last report, it will be found that the expense to each locomotive (employed in most of the Middle and Western States) due to impure water and incrustation is more than $750 a year. We have not calculated the probable outlay attending the continued use of reservoirs, and it would be difficult to do so until some experiments have been made in that direction. Mr. C. T. Ham, formerly of the New York Central, stated in Convention last year that there were a number of them in use on that road, and they were giving good results. Surface water can be easily and cheaply stored by a proper arrangment of draining, and your Committee would recommend this plan of water supply, whenever it can be done, until a better way presents itself.

In this connection, Mr. Reuben Wells, of the Jeffersonville, Madison & Indianapolis Railroad, states that "rain water should be gathered wherever it can be, and used as far as possible, and if a sufficient quantity can not be had for a full supply, use the purest water that can be got to make up the deficiency. In this way, most roads could be supplied by bringing water from rivers and creeks at a

ıasonable distance, and thus greatly improve the average quality ;ed in their engines at a comparatively small outlay. There may, ' course, be sections of country where very little can be saved in iis manner, yet in many places it could be done to great advange."

This plan is entirely consistent, and, if not the very best, it is certinly the most feasible. Yet it is not without its objections. Surice water, especially that of rivers and streams, is more or less imregnated with lime and other salts of the earth, and during seasons f heavy rains and high water it is sometimes almost thick with mud, ie use of which causes boilers to foam, besides producing a formaon of incrustation in proportion to the amount of impurities conined in the water.

Mr. Elliott, of the Ohio & Mississippi, thinks this difficulty might e obviated "by placing a sufficient number of settling tubs at each oint, and arrange to draw the water into tenders without taking the ıud with it."

But this arrangement would involve quite an expenditure in the ay of extra tubs and frost-proof buildings, which would be an obction. What we need is strictly pure rain water, gathered in waterght reservoirs. But a question of expense is here again presented, hich at first sight would seem to prevent the introduction of such a extensive work. Yet, if the general average rainfall was equal ı that in the State of Missouri, a hope might be entertained of the iccess of such an arrangement. The rainfall in Missouri, according ı "Campbell's New Atlas of Missouri," is, highest, 68 inches; west, 25, and average, 41. The average being 41 inches, it would ily require a reservoir the size of an acre, 16 to 18 feet deep, every renty miles, having a roof or sloping surface of three (3) acres ading to it, to supply the heaviest traffic—twenty engines, or ten ains a day each way. One engine, according to the last annual rert, will consume 1,039,500 gallons of water, running 31,200 miles year, equal to 20,790,000 gallons for twenty engines. The four res of surface, or one reservoir, would catch 4,573,810 gallons, and e such reservoirs will contain 22,869,000 gallons, or more than ıugh to supply the whole number of engines. If this plan should found practicable, the reservoir could be placed on high ground,

so as to supply from the bottom, a water crane, placed at the lowest point in the track from which the tenders of the engines could be filled, thus doing away with all wells, tubs, buildings, pumps, labor, etc., attending the present cost of water supply. At all events, a large amount of rain water can be easily gathered in ordinary ponds, and if scraped out to a clay bottom, and the banks protected from washing and other disturbances, we would have a very excellent quality of water, comparatively free from mud and mineral impurities.

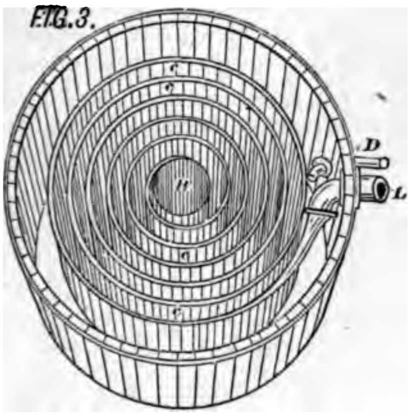
Your Committee would again earnestly recommend the use of rain and surface water wherever it can be gathered, and they believe it to be the only practical way of getting over the difficulty. Strictly pure rain water will soften incrustation if used exclusively for several days, and if its use be continued for sixty days, we have no doubt it would remove the scale of six months' or a year's accumulation. We have not yet experimented sufficiently to determine positively the effect of this treatment on hard mineral scale, but we trust by another year this point will be settled, when we shall find "boiler compounds" falling from the clouds, and within the reach of all.

Our experience with the "mud drum" has been too limited to know its merits. We think, however, it is a benefit in keeping the cylinder part of the boiler free from mud and other floating impurities, providing they are properly used. They should be fitted with a blow-off cock, under the control of the engineer, which should be opened two or three times every one hundred miles, and at times when the engine is subjected to its maximum pressure, thus producing, by the force of the steam and water passing through the cock, an eddy that will take with it any loose sediment within its reach.

From our own experience, we do not consider wash holes in the sides of the boilers, for the purpose of washing off crown sheets, of sufficient practical value to recommend them.

We believe the subject is now pretty well defined, and its future development will depend more upon the disposition of railway companies to carry out the experiments suggested in the way of storing rain and surface water than upon the efforts of any individual or private corporation.

FIG. 3.



H. A. TOWNE'S

IMPROVEMENT ON

Draper's & Covington's Condenser.

as been the aim of the Committee, in their investigations of bject, to deal only with facts, being particularly careful not to nend anything which in their judgment involves a doubt. It s yet to be proven how nearly they have come to a solution of estion, and until something more definite is reached touching he above allusions, we apprehend we shall be no wiser in this on.

onclusion, your Committee desire to express their appreciation valuable services rendered by Prof. J. A. Sewall, in the labor attending the several analyses made by him. And they also extend their thanks to the superintendents who have furnished him passes, in consideration of such services for nefit of the Association as well as railroad companies gener-

Respectfully,

H. A. TOWNE,
H. & St. Joe R. R.
A. H. De CLERCQ,
T., P. & W. R. R.
HARRY ELLIOT,
O. & M. R. R.
} *Committee.*

notion, the following letter was read with the report:

ENGINEERING OFFICE OF WALTON W. EVANS,
NEW YORK, May 13, 1873.

TOWNE, *Esq., and others, Committee of the Master Mechanics' Associa- ppointed to examine into and report on the Evils of Boiler Incrustation:*

TLEMEN—I must apologize for not sooner sending to you an- to the questions asked in your circular. I believe, with you, e most effectual remedy will be to purify the water before it nto the boiler. I am glad to see this subject taken up by your ation, as it is one of vast importance. The use of impure has been the cause of much railway expenditure, and no doubt en at the bottom of many terrible accidents. The question is ly philosophic and chemical one, and should be so considered stigating it. I will with pleasure give you my views and expe- with bad water, but it is for learned and able chemists to say

what is the best and most economical method to adopt of ridding water of its impurities. This should be done at the expense of the railway companies, and I have no doubt that they would save a large sum every year by appointing a body of eminent chemists to examine the subject and report on it, after having investigated practically the merits of all methods and ways of purifying water. Such an investigation will cost money and take time, but for every dollar expended in this way the return will be a hundred fold or more.

The impurities in water, as regards their action in locomotive boilers, should be classed under two heads—those that create incrustations and those that create priming or foaming. The former are due to the existence of carbonates and sulphates of lime, chiefly the latter. The priming is occasioned chiefly by the existence of chlorides; but priming takes place sometimes with water that is very pure. Priming, in these cases, has never been satisfactorily accounted for. Having had much trouble with water, and finding that the engines on the London & North-western Railway, of England, could not use the water from a well at Camdentown, sunk through the London clay, on account of priming, I procured some and had it analyzed by Prof. Hoffman. It had only 6½ grains of impurities in an imperial gallon of 70,000 grains. Robt. Stephenson, the engineer of the railway, afterward showed me an analysis of this water giving the same result, and yet this water, nearly as pure as the Croton water of this city, could not be used in their engines.

I will take up your questions and answer them *seriatem:*

1. I am not in charge of any railway, but, as I take much interest in this matter, I beg to offer some remarks.

I know of very few stations where the purification can not be effected on the spot, by heat or by chemicals, the carbonate and sulphate of lime being the chief impurities to get rid of. It remains with each railway to find out by experiment which is the cheapest method. Distilling water carefully gets rid of nearly all the impurities, but this is an expensive process. To precipitate the carbonates and sulphates, by the use of heat, to drive off in gas the acids that hold the impurities in solution appears to be a good method, but how perfect it is I can not say. Chemists can easily solve this question. Clarke's process of precipitating carbonate of lime by putting

ore lime in is a beautiful and most perfect process, easily demonstrated and proved. How far any similar process may be made to work with sulphates I am not learned enough in chemistry to say. The chlorides can not be precipitated, but they never make incrustations.

My attention was some time since called to the invention of a very clever young machinist that I sent to South America. His invention is an apparatus for manufacturing salt by revolving heated cylinders in salt water, the cylinders being heated by steam passed through the shaft on which they revolved. The salt, leaving the chlorine which held it in solution, attaches itself to the cylinder, which is part in and part out of water, and is cut off by a knife when it gets to a proper place. This machine is in practical use, I understand, at Syracuse. The inventor tells me he can take sugar, lime, or any other salt out of water that is held in solution, and leave it chemically pure. This I doubt, but the apparatus is worthy of consideration. It struck me that if the inventor could do what he said he had done, or something near to it, it would be found a cheap and ready method to purify water for engines.

I have found very perfect results in the south of Peru, where the water was bad, by using Dantie's process, which is to heat the water, and mix with it a small quantity of the hydrate of barytes. What the chemical reaction was I can not say, but the result was perfect. No scale ever took place, the inside surfaces were smooth, and in a measure slippery. This process is English. It poisons the water for drinking purposes.

On the west coast of South America, where I have been long connected with the railways, we had many and serious difficulties with the water. The only water they have for 2,000 miles is that from melted snow in the mountains, which, on its way to the sea, picks up all manner of impurity, so that much of it is not fit to go in a boiler. At some points there is no water but the sea water. This has to be distilled, at much expense, with coal brought from England.

In 1852, I distilled, at Caldera, all the water used on the Copiopo Railway. At Iqueque, in Peru, they now distill all they use. At Arica I used the hydrate of barytes. At Mollendo the water was distilled for the Araquipa Railway, but now they are laying an eight-

inch pipe the entire distance of the railway, 107 miles, to bri[ng] water from the city of Araquipa, 7,550 feet above the sea. At C[…] dera the water had 370 grains of impurities in 70,000. Much [of] this was chloride of soda (common salt) which could not be preci[pi]tated.

2. It is practicable to store rain water in reservoirs, and there [are] but few places where reservoirs can not be easily and cheaply b[uilt] and filled with rain water, even when the rainfall is less than [...] inches. The whole of Central India, where the rainfall is from [...] 7 inches in three months, depends for its crops and the very ex[ist]ence of its people on water stored in reservoirs called tanks, m[any] of which are as large as lakes. I have recently seen the maps of t[he] storage reservoirs of India. They are truly wonderful evidences [of] human industry, the province of Mysore having over 30,000 of these storage reservoirs.

3. Rain water, as it falls from the heavens, is pretty nearly pure water, and is no doubt first-class water to use in engines. There can be no scale resulting from its use. It does not require to be filtered, unless it has been allowed to pick up organic matter after it fell. Inorganic matter, if in its mineral condition, will precipitate itself. Inorganic matter in solution can not be filtered out; it must be removed by heat or chemicals.

4. Distilled water ought not to be injurious to boilers; if it is so, it must result, I think, from its being deprived of its power to hold air or get air, or carbonic acid gas, which gives to water a certain life. Then, again, distilled water may be impregnated with a poison, or injurious matter, from the apparatus in which it was distilled.

5. Distilled salt water, if any more injurious to a boiler than distilled fresh water, must be the result of poor distillation, some of the salts being carried over with the steam, salt water being more liable to prime than fresh water.

6. The chemical properties of distilled sea water ought to be the same as pure water, which is a chemical compound, and consists of 7 parts of oxygen and 1 part of hydrogen; but, as it is very difficult to distill water on a small scale and get it chemically pure, it is almost impossible to do it on a large scale, some of the impurities

ıg carried over into the condenser in other forms than that of e vapor. This being the case, the water distilled from the sea in ntity is liable to have in it some of all the impurities of sea ır, which are many, the chief being lime, magnesia, soda, sulric acid, and muriatic acid.

Boiling the water, and driving off the carbonic acid and sulric acid in the form of gas, which holds the carbonates and sultes in solution, will result, if thoroughly done, in precipitating e of the impurities—all that form scale—but not those that ocon priming. Chloride of soda (common salt) will not be precipid until the evaporation has reduced the water beyond the point aturation, and then only that portion that can not be held. A tical trial of this boiling method would be important to try, but ıould be done under the eye of an experienced and able chemist, could thoroughly investigate the results and report on them. I ld name Dr. Chandler, of the "School of Mines," as the most petent man for this purpose that I know of, he having examined reported on the waters of the New York Central Railway some rs since.

I have no practical knowledge of the mud drum. Many, if not of your members know much more of the practical benefit of than I do.

I am, gentlemen, your obedient servant,

W. W. EVANS,
Associate Member M. M. Ass'n.

'. S. I beg to inform the Association, through you, that we are ning our American built locomotives in Peru, on the Pimo Rail-, over the summit of the Cordilleras, 14,600 feet above the level he sea, and that the engines are working at that great height 1 marked success.

would also state that we are cutting a tunnel for the Oroya Rail- (another road that is to cross the Cordilleras), the floor of which el is 15,722 above the sea, and that we expect to have our ens up to the mouth of this tunnel in a short time, and the tunnel, h is 3,700 feet long, completed in one year.

W. W. E.

Mr. KEELER, Flint & Pere Marquette Railroad—I move the report and letters be received and the Committee continued.

Carried.

Mr. COLEMAN SELLERS, of Philadelphia—Mr. President, at the last meeting of this Association, in Boston, when the report of the very able committee on this subject was presented, it was I who first mentioned the effect of pure water upon the boilers of ocean steamers. Since that time I have had frequent conversations with persons who have been constructing surface condensers. I asked them the question, what caused the deterioration in the boilers of ocean steamers, as far as they could judge from their experience with ocean boilers. They informed me it was caused, in great part, by an acid generated by the press in the boilers when the surface condensers are in operation. I think there is no doubt that the deterioration in ocean boilers is due to the pure water—to the acid created in the production of that pure water from sea water, which passes over the iron in the distillation and weakens the material. I have had the planning of chemical laboratories, and, in conversation with persons connected with such works, have gathered a good deal of information about the accumulation of acids in water by the process of distillation. Iron tanks are not used at all in such distillations, the affinity between pure water and iron being such that they *will* go together, thereby making the distillation useless. Extracting the substance of the iron in this way must necessarily weaken the vessel; and so it is with the use of distilled sea water on ocean steamers. The importance of this snbject varies in different sections of the country, however, according to the circumstances with which operators have to contend. Thus, people who are in Pennsylvania have very little interest in the subject of incrustation; their desire is to obtain some means of forming slight incrustation. In those sections of the country where pure water, whether rain or obtained by distillation, is used, the deleterious effects of the water may be overcome by the addition of ordinary water to the quantity.

Mr. J. O. D. LILLEY, of Indianapolis—Mr. President, I regard this as one of the most important questions that can come before the Convention, and I do not think we can make it any too strong. I, for one, think the Committee should be increased, and would move you that Mr. Sellers, of Philadelphia, and Mr. Peeples, of the Central Railroad of New Jersey, be added to the Committee.

Mr. SETCHEL, Little Miami Railroad—Mr. President, this is a question which must interest, and deeply interest, every Master Mechanic whose privilege it has been to examine the condition of old boilers, and see the vast accumulation of scale they contract from the use of impure water. The subject, I think, has been very fully investigated by the Committee, especially by the able Chairman of the Committee, Mr. Towne. I think we can all say to-day that this evil is very much on the decrease, and I think that the

Master Mechanics' Association may take to itself the credit for this fact. The principal difficulty has been that railroad companies have built their water tanks where they could get water cheapest, instead of where they could get it of the best quality for boiler consumption. Hence, in constructing railroads, rivers of soft water would be passed, and the water taken from springs where sufficient head could be obtained for the water to flow into the tank without the labor and expense of pumping. In the early days of railroading, many, I suppose, did this without dreaming of the difference between the use of hard and soft water. Master Mechanics, and other similar bodies, have agitated the subject until railroad companies have been forced to see their error, and now the old tanks of hard spring water are fast disappearing, and giving place to new tanks for soft, and reservoirs for surface water. It seems to me that the Committee have arrived at a very practical conclusion—that the only remedy for this rapid accumulation of incrustation in boilers is for railroads first to make use of the natural means for obtaining pure water on their lines. When this is done, there will be but little incrustation compared with what there is now. We had a great deal of trouble with our boilers and flues before the introduction of soft water, but since we get the most of our water from rivers the trouble is slight. We don't have as much scale in a year now as we formerly had in three or four months. I think the only rational conclusion is that water from streams, and surface water gathered in reservoirs, is the greatest preventive of incrustation, and should be used by all roads when it is possible; and I would like to see a resolution adopted by this Convention giving that as the opinion of the Association.

Mr. W. Woodcock, Central Railroad of New Jersey—Mr. President, I have given the subject of the formation of scale in boilers considerable attention, and have brought along with me, for exhibition to the members here, a piece of boiler which I took out of one of our engines a short time ago. You can see it is almost destroyed by scale. There were other boilers similarly affected by the use of hard water, as I believe, but this will serve as a sample.

Mr. Gorman, Toledo, Wabash & Western Railroad—I coincide with the views of Mr. Setchel. My experience has been about like his. We were using a great deal of hard water on our road, and, seeing what an expense it was in the care of engine boilers, fuel, etc., we tried the experiment of surface water and reservoirs. Since then there has been a great change for the better, scale not accumulating anything like it formerly did.

Mr. Harry Elliott, Ohio & Mississippi Railroad—Mr. President, it would better answer the purpose, I think, to appoint a new committee altogether. I know that that is Mr. Towne's feeling. The Committee has considered the subject for some time without coming to any definite conclusion,

and a new committee might take another view of the matter and bring up something that might not be likely to come from the old Committee.

Mr. KEELER, Flint & Pere Marquette Railroad—I think the old Committee had better be continued, with the additions proposed. The old Committee is certainly more familiar with the subject, and are more capable of getting information than any new committee that could be appointed.

Mr. Lilley's motion was carried.

THE PRESIDENT—I would state that I have received a communication from Mr. Towne, stating that Prof. J. A. Sewall had rendered the Association a good deal of service in the analysis of water sent to him from the various roads, and that he (Mr. Towne) would like to have a resolution passed by the Convention which the Secretary will read.

The Secretary read the following:

"*Resolved*, That this Convention do fully appreciate the valuable services rendered by Prof. J. A. Sewall in the tedious labor attending the several analyses of water made by him, as stated by the Committee on the subject of Boiler Incrustation and the Purification of Water, and they would extend their sincere thanks for the special interest manifested by him in a work so important to this Association."

The resolution was adopted.

Mr. GLASS, Allegheny Valley Railroad—Mr. President, I move that Mr. Towne be reimbursed for the amount expended by him in getting up this report.

Mr. LILLEY, of Indianapolis—In connection with this resolution, which I trust will be adopted, I would like to urge upon the Master Mechanics' Association the importance of not restricting their committees too closely, so far as the expenditure of money is concerned, in the investigation of any subject given to them for consideration. They ought to go into their inquires feeling that the Association will bear them out in any expense they may incur that is necessary for the prosecution of their investigation. If they have not that assurance, the item of expense might deter them from carrying their inquiries to the extent we would wish. I hope the precedent established to-day of paying the expenses of all necessary scientific inquiries that may be conducted by our committees will be carried out.

Mr. FRY, Grand Trunk Railroad of Canada—Mr. President, I am in favor of paying the bill, and whatever other expense the Committee may have gone to; but, Mr. President, I would suggest that the Committee employ some thoroughly educated chemist, at some reasonable figure, to make analyses of all specimens of water that may be sent to them from the various railroads. There are a good many of the members of the Association who are not near a reliable chemist, and can not, therefore, have tests of water made when they want them. By the adoption of the suggestion I have

ıade, we would have a recognized authority on such matters, we would have he work done cheaper than we can by giving it out by jobs, and would all now just where to send our samples. I think that would be better than to llow committees to go to an expense of three or four hundred dollars for he analysis of water all over the country.

Mr. EDDY, Boston & Albany Railroad—Mr. President, it seems to me that re are going into things rather largely, considering what funds we have or rhat we are likely to have. Fifty or seventy-five dollars for what has been one is all right enough, but, when it comes to authorizing a committee to pend three or four hundred dollars for we don't know what, I think we are etting beyond ourselves. I don't think that, under present circumstances, he Association should leave any such loop-hole. I think, in passing the ther resolution, we are establishing a precedent which it would be better to e in operation before we go further on this line.

Mr. KEELER, Flint & Pere Marquette Railroad—I would move, as an mendment, Mr. President, that the various railroads sending specimens of ater for analysis pay the expense of the operation themselves.

Mr. FRY, Grand Trunk Railroad—That was my intention, Mr. President. ly idea was to have the Master Mechanic of any road send specimens of ater which he desired to have analyzed to this Committee, the Committee have the work done by the chemist whom they employ, and the expense be borne by the railroad company from whose line the specimen is sent. If at was not understood when I made my motion, I accept the gentleman's mendment.

Mr. BROWN, Erie Railroad—Mr. President, that is the way the thing ould be done, I think. There certainly is no railroad in the country which ould not cheerfully bear the expense of an analysis of the water on its line commended by its Master Mechanic.

THE PRESIDENT—The motion is, gentlemen, that the Committee be reuested to appoint one of its members to receive from any member of the ssociation such specimens of water as he may require to be analyzed, to have it tested by some competent chemist, and return the analysis to the laster Mechanic sending it, the test to be made at the expense of the comany with which the Master Mechanic is connected.

Mr. EDDY, Boston & Albany Railroad—Mr. President, it would doubtless a great satisfaction to our men in Boston to know that they can send water r analysis out to Omaha, or Chicago, or somewhere else. Possibly, though, ey might think there were chemists nearer home who could do the job just well. I think the railroads should select their own chemists to analyze eir water at their own expense.

The motion, being put to a vote, was carried.

Mr. HUDSON, Rodgers' Locomotive Works—Mr. President, as this is a ry important subject, and we can not learn too much about it, I would sug-

gest that when they send water for analysis that the chemist ascertain the e fect of the water distilled from it on different kinds of boiler iron in whic the distilled water is used. In Peru, Chilli, and some other of those Sout American countries, where it doesn't rain for six months sometimes, perha a year, they have to distill all their water. As to the precise effect of tl distilled water on iron, I am not informed, but I understand is most i jurious.

Mr. SETCHEL, Little Miami Railroad—If it would properly come und this head, I beg leave to offer the following resolution. It seems to me th it should hardly be left to to the Committee to incur *any* expense they m think best, because they may not always know the financial condition of tl Association, and it is always best to keep within our income:

"*Resolved*, That no expense shall be incurred by committees except by tl unanimous consent of the General Supervisory Committee, given in writi to the chairman of said committee, stating the amount to be expended."

The resolution was adopted.

Mr. SETCHEL, Little Miami Railroad—Mr. President, if no one else d sires to say anything on the subject of incrustation, I move the discussic be closed.

Carried.

Mr. Chapman, from the Committee on Correspondence. submitted the fo lowing report:

Report of Committee on Correspondence.

MAY, 1873.

To the Members of the American Railway Master Mechanics' Association:

We, the Committee on Invitations, beg leave to report the fo lowing:

Tuesday—Excursion by steamer to Annapolis, to visit Nav School, old State House, etc. Leave Light Street Wharf, foot Light street, at 1:30 P. M. this day.

Wednesday—Carriage drive to Druid Hill Park. Leave hotel 4 P. M.

Thursday—Excursion by train from Camden depot, leaving abo 3:50 P. M. for Baltimore & Ohio Work Shops, at Mount Clair.

Friday—Excursion by train, Baltimore & Ohio Railroad, to Was ington, as soon after 8 A. M. as possible.

The Committee regret that the invitation from New York can n be accepted in the form presented, but, understanding from the del

tion sent from New York, that the date can be changed, we there- e recommend that the invitation be accepted as follows for

Saturday—Members leave Baltimore about 8 A. M. Saturday for w York. On arrival, carriage drive through Central Park, and nquet at St. Nicholas Hotel at 8 P. M. of the same evening.

The following invitations are recommended to be very respectfully clined, with regret, on account of the impracticability of accept- g them:

Union Railroad Company, visit to tunnel, etc.

Canton Company, of Baltimore, in respect to land, etc.

J. H. Du Barry, Esq., Vice-President of the B. & P. Railroad, an excursion to Gettysburg, etc.

N. E. CHAPMAN,

Chairman of Committee.

The report was accepted.

Mr. BROWN, Erie Railroad—I would like to inquire of the Committee ether it is expedient to take an excursion to Gettysburg? How far is ttysburg from here?

Mr. FLYNN, Western & Atlantic Railroad—The Committee was informed t it is seventy-five miles, and as a visit there would consume the best part a day, and there are many members who have never been to Washington, Committee thought we had better go to Washington than Gettysburg. can go to Washington in fifty minutes, while it will take us a whole day make the trip to Gettysburg and back, if we want to see anything while re.

Mr. BROWN, Erie Railroad—I move that we substitute a visit to Gettys- g on Thursday for the ride to Druid Hill Park, that is if the visit can be de in one day.

Motion withdrawn.

Mr. MORRIS SELLERS, of Pittsburgh—Mr. President, I would suggest t as there are many members who would like to visit Gettysburg, that we to New York on Saturday by the way of Harrisburg and Philadelphia, ich will give us an opportunity to stop off and visit Gettysburg. That ngement would put us in New York Saturday evening in time for the quet, and would only take out of the programme the ride through Cen- Park.

Mr. BROWN, Erie Railroad—I move that we hold a night session of the vention that we may have a day for a visit to Gettysburg.

r. SETCHEL, Little Miami Railroad—It seems to me that we should not

go out of the general order of business to partake of any banquet, go on an excursion, nor make any engagement if the business of the Association going to suffer thereby. I am entirely opposed to making the occasion of tl assembling of our Convention the time for any pleasure or recreation whi ever that will detract from the good of the Association. [Applause.] I thin Mr. President, that it will be readily seen that it will be an impossibility get a full attendance here in the evening; besides we can best do our bu ness in the daytime. It seems to me that we should adopt the maxi "Business first and pleasure afterwards."

Mr. MORRIS SELLERS, of Pittsburgh—Mr. President, there is no one wl will indorse Mr. Setchel's remarks more readily than I. "Business first a pleasure afterwards," say I, too. I only made the suggestion that we go New York by the way of Harrisburg, in order to stop at Gettysburg, becau a number of members have expressed a desire to see the place. On Satu day our business will be over, and the arrangement I have suggested can no way interfere with the transaction of what we have to do in Conventio

Mr. FLYNN, Western & Atlantic Railroad—I will state, Mr. Preside that nothing would afford me greater pleasure than a visit to Gettysburg. would take more pleasure in going there than in going to Washington, b cause I have seen the Capital before. But the Committee had to take in consideration what was best to do under the circumstances. Our only obje in making the report we have was to give satisfaction to the members. W have done what we thought best. A committee of our New York frien has kindly been sent here, inviting us to that city, and when we said could not very well go there on Friday, as they had arranged, they chee fully said they would make the change to Saturday to suit our views. Th propose to leave here at 8 or half past 8 o'clock in the morning, to arrive New York early in the afternoon, when carriages will be in waiting to ta us on a ride through Central Park, returning to the city in time for the ba quet. I think it would be difficult for Mr. Sellers to get to New York an stop at Gettysburg, as he proposes.

Mr. KEELER, Flint & Pere Marquette Railroad—I move, as a substitu for the motion before the Convention, that the report of the Committee b adopted as presented.

By consent, Mr. Brown, Erie Railroad, withdrew his motion.

Mr. SELLERS, of Pittsburgh—Then I move, Mr. President, that we go t New York by the way of Harrisburg, on Saturday, stopping at Gettysbur The transportation will be the same.

Mr. ROBINSON, Great Western Railroad, Canada—I do not think there any necessity for a clashing of views on this arrangement. It may be ma a matter of convenience altogether. Many of the members wish to go Gettysburg; if they can do so, let them go to New York by that rou Others prefer to get to New York in time to see Central Park; let them

to New York direct. There is no reason that I can see why both parties should not be accommodated.

Mr. LILLY, of Indianapolis—I think there are many members here who doubt the feasibility of winding up our Convention with a banquet at New York on Saturday night. I have heard a good many members say that they will not go to the banquet. The railroad men of the country are looking at us pretty closely, and if our conduct is such as to give the impression that we are acting unbecoming, I do not think our labors will be appreciated. We do not meet here to have a good time, feasting, going on excursions, and all that sort of thing, but for the transaction of business, for the consideration of important subjects, and for the purpose of adding to our stock of information. Now, *some* of the members seem to be wanting to get to New York in time for that banquet. The banquet is the objective point all the time. I doubt the propriety of our going there at all, but I am a democrat, and will give way to the majority if I'm outvoted. I hope, though, we will not let either New York or the banquet trouble us until we get through with the Convention.

Mr. FLYNN, Western & Atlanta Railroad—Mr. President, I would state, in regard to the banquet spoken of, that our New York friends have arranged it for us at considerable trouble and expense, and have sent a committee to see us safely there. They have postponed the banquet until Saturday evening to meet our views, and not to go there now would be treating New York rather shabbily.

Mr. LILLY, of Indianapolis—Mr. President, I do not want to hurt anybody's feelings, but it does seem to me that the great anxiety to get to this banquet is a little unbecoming to the Association. We are in Baltimore now, not New York, and if we have leisure time to spend in the enjoyment of hospitalities that may be tendered, let us give Baltimore the preference.

Mr. SELLERS, of Pittsburgh—Mr. President, I don't believe anybody who knows anything about the Master Mechanics' Association thinks we meet to spree or have a good time generally. I do not approve of indulging in any excesses whatever, but when the Convention assembles and when our business is over hospitalities are kindly extended to us, I do not think we are sacrificing a particle of honor or dignity in accepting them in the spirit in which they are offered.

Mr. ROBINSON, Great Western Railroad—As a member of the Committee, I would say that the Committee were in doubt as to the feeling of the Convention on the proposed trip to New York, and I am glad that this discussion has taken place. As our New York friends have prepared everything for our entertainment on Saturday, we thought it would be treating them slightingly to report against accepting their invitation, and yet we knew that some members of the Association were opposed to the banquet. I would

recommend that the Committee take Saturday's operations in its own hands altogether.

The motion of Morris Sellers to proceed to New York by way of Gettysburg on Saturday was carried.

Mr. DURGIN, of Pittsburgh—I would suggest, Mr. President, that there is nothing obligatory in this matter. All those who want to go to New York and to the banquet can do so, and those who want to go home from here can do so.

Mr. FORNEY, Railroad Gazette—I would like to state, Mr. President, that a Committee on Premiums to be given for the best drawings on certain subjects, at our last meeting, was appointed, and if any of the members have drawings to enter for the premiums, if they will place them in the hands of the Committee they will be duly considered.

THE PRESIDENT—The members will please bear in mind Mr. Forney's remarks. The next business in order will be the reading of the report of the Committee on the Comparative Value of Anthracite and Bituminous Coal and Wood for Generating Steam in Locomotives.

Report of Committee on the Comparative Value of Anthracite and Bituminous Coal and Wood for Generating Steam in Locomotives.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee on the Comparative Value of Anthracite Coal, Bituminous Coal, and Wood for Generating Steam in Locomotives have received nineteen replies to their circular of questions on this subject; seventeen of these are from Railroad Master Mechanics, and two from gentlemen who do not now represent any railroad. The information furnished therein, as a rule, is so meager and incomplete as to prevent our making a report therefrom that will be of interest to the Association.

It is necessary, in order to compile a reliable report on this subject, that all the questions in tabular form, as per circular, with reference to the kind of fuel burned be answered, namely:

Average cost of fuel placed on tender.

Average number of gross tons of freight, or average number of passenger cars hauled by one engine.

Average cost per mile for any given weight of freight train, or number of passenger cars hauled.

In the replies received, some have stated the cost per mile for fuel, and have omitted the cost of the fuel placed on the tender. Others, again, have answered both these questions, but have omitted the weight of freight trains or number of passenger cars hauled, and a few merely state the kind of fuel they use, and give no data.

Almost all the roads from which we have received replies burn bituminous coal and wood, and a large majority of these prefer *wood*, both for economy of repairs of furnace, etc., and the cleanliness and comfort to passengers; a few have a preference for bituminous coal over wood on account of the danger (with wood-burning engines) from the sparks to wooden structures on line of railroad; and, as regards the comfort of passengers, one replies that the objection to bituminous coal is entirely obviated by using the "Jauriet Fire Box."

With reference to the advisability of paying more for one kind of fuel for passenger service especially, on account of comfort to passengers, there are various opinions expressed. Some think the discomfort from smoke or sparks may be overcome by mechanical or other contrivances—for instance, in the build of furnace, exhaust, use of spark arresters, etc. Others, again, provided the expense is not too great, are in favor of paying an extra price, and state a decided preference for anthracite coal over the other two fuels named.

We have but one reply from a road burning anthracite coal, and the opinion therein expressed I (as representing another anthracite coal-burning road—the Lackawanna & Bloomsburg) fully concur with. It reads as follows:

"We prefer anthracite coal for cleanliness and economy; am not prepared to say how much more we would be willing to pay for anthracite over bituminous coal for our passenger engines, but we would not exchange the hard for the soft coal under any circumstances other than absolute necessity. The difference as to cleanliness and comfort is too great for comparison."

Another road, having but three anthracite coal-burning engines, also states a decided preference for anthracite coal.

As your Committee deem this subject of much importance to the

Association, we would respectfully recommend that it be continued another year.

CHAS. GRAHAM,
M. M., L. & B. R. R.
L. S. YOUNG,
M. M., C., C., C. & I. R. R.
B. H. KIDDER,
M. M., L. S. & M. S. R. R.
Committee.

Mr. BROWN, Erie Railroad—I move the report be received and the Committee continued.

Carried.

Mr. ROBINSON, Great Western Railroad—I would suggest to the Committee the propriety of giving a little more heading to their circulars, when they continue their labor during the coming year, than they have previously. What we want to know is the relative value of the two kinds of coal and wood, and to get at that we must determine the amount of the several classes of fuel consumed per ton hauled per mile. That is the only way these reports can be made of any value to us. It is important, too, that such a record should be kept, in order that the company may see whether it is getting the full value of the coal or wood consumed.

Mr. FLYNN, Western & Atlanta Railroad—Mr. President, I am quite a novice in the use of coal as yet, and can not, therefore, give much information as to the comparative value of the different kinds of fuel. I am trying an experiment, however, which I expect to give me a good deal of information on the subject in the course of time. I am running two engines, of the same identical pattern, one using coal, the other wood. So far as I have arrived at any conclusions from this test, they are that the wood-burning engine requires twelve and a half cords of wood to make a trip averaging 28 running days, and that it would take nine tons of coal for the coal-burning engine to make the same trip. The coal costs $3 a ton, delivered in Chattanooga, or $27 for the trip. We pay $3 a cord for the wood. Whether the extra cost of repairing the coal-burning engine would make up the saving on fuel over the wood-burning engine I cannot say, as the comparison has not been going on long enough for me to determine definitely. The work of the two engines is carefully registered, and at the end of the year I expect to be able to tell the Association something about the relative cost of at least wood and coal for locomotive purposes by fair and actual tests.

Mr. HUDSON, Rogers' Locomotive Works—Mr. President, it is not only the actual cost of fuel per mile that we want to arrive at, but we also want to find out the relative wear and tear on boiler material by the several kinds of fuel. There is a great difference in the boilers of locomotives using coal

and those using wood, and also between bituminous and anthracite coal. I was asked by some officials connected with an important railroad, the other day, as to what I knew of the relative wear and tear on boilers heated by anthracite and those using bituminous coal. The opinion I have on the subject is not of very much consequence, but it is like this, so far as I have been able to determine, that anthracite coal abrades and wears out the material of furnaces, whether iron or copper, very much faster than bituminous coal, and bituminous coal wears out the material of boilers faster than wood. Therefore, I say, take into account, in considering this question, the relative wear and tear on boiler material, as well as the actual cost of the fuel consumed.

Mr. Robinson, Great Western Railroad—My opinion is that the tubes and fire boxes in soft-coal-burning engines last about half as long as those of wood-burning engines; that is to say, to run a coal-burning engine as long as a wood-burner, counting the lifetime of a locomotive fifteen years, you would have to put in new tubes about the seventh year. In wood-burners they will last as long as the boiler itself. Of course this cost must be counted against the cheapness of burning coal.

Mr. Brown, Erie Railroad—Mr. President, it is useless, in my opinion, to discuss the question between wood and coal. We can not afford to burn wood—that is settled. Each road must determine which is the cheaper for it to burn, hard or soft coal; and when you have have settled that you are as near a solution of the problem as you will ever get.

Mr. Flynn, Western & Atlanta Railroad—Two-thirds of the mileage of the United States is run with wood. I don't think I exaggerate any in putting it at that figure. The presiding officers of all the railroads will ask the question oftentimes, which is cheapest, coal or wood? and we must be prepared to answer. It is a question for all sections of the country to consider. My impression has been, up to lately, that wood was a great deal the cheapest. My impression, formed in the last two months, is that my former opinion was not correct—that coal may be made the cheapest.

Mr. Robinson, Great Western Railroad—I agree with Mr. Flynn that the Master Mechanics should fully inform themselves on this subject. Besides the roads now in operation there will be new roads constantly asking the question as to what fuel they shall adopt, and we ought to be able to give information on the subject.

Mr. J. L. White, Evansville & Crawfordsville Railroad—Mr. President, I think it depends largely upon the section of country in which the railroad is operated. I know very well, though, that locomotives burning wood last much longer than those burning coal. I know of a wood-burning engine that has lasted twenty years, and is in good condition now. On the other hand, we burn out furnaces in coal-burning engines in twelve months, sometimes. It must be said that a good deal depends on the shape of the furnace

in burning coal. The furnace should be large, so that the fire can be made, as a blacksmith would say, a "soft" and not a sharp fire. If the furnace is built the right way, and care is taken with the firing, the iron will last nine or ten years in coal-burning engines.

Mr. ROBINSON, Great Western Railroad—As there are some other matters connected with this subject that ought to receive some attention, I move that the discussion on this subject be postponed until to-morrow morning at nine o'clock.

The motion was carried.

Mr. SETCHEL, Little Miami Railroad—Mr. President, I move that a committee of three be appointed to prepare subjects for discussion at the next annual meeting of the Association.

The motion was carried, and the President appointed as such committee, Messrs. Brown of the Erie Railroad, Fry of the Grand Trunk Railroad, and Underhill of the Boston & Albany Railroad.

Adjourned to nine o'clock Wednesday morning.

SECOND DAY'S PROCEEDINGS.

WEDNESDAY, MAY 14TH.

The Convention met at 9 o clock A. M., President Britton in the chair.

The President announced that the first business in order would be the continuation of the discussion of the report of the Committee on the Comparative Value of Anthracite and Bituminous Coal and Wood for Generating Steam in Locomotives.

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—Mr. President, before proceeding to the regular order of the day, I move that a temporary committee of three be appointed on finance, to act in the absence of the regular committee in examining the accounts of the Association, and reporting the amount of assessment necessary for this year.

The motion was carried, and the President appointed as such committee, Messrs. Waite of the Boston & Maine Railroad, Van Vetchen of the Atlantic & Great Western Railroad, and J. Kelly of the Providence & Wooster Railroad.

Mr. ROBINSON, Great Western Railroad—We were discussing the relative value of anthracite and bituminous coal and wood, at the close of yesterday's meeting, and I was speaking of the meagerness of the information contained

he reports made on the question in response to the Committee's circular. ink we shall all agree that these reports to be useful must be made intelble, and not only intelligible, but also drawn up on the same basis. I assure you, Mr. President, that this is a question with which every Mas- Mechanic in this room must familiarize himself. A short time ago the cutive officers of the road which I represent sent down to my office an act from a certain report, showing that the consumption of fuel on the l was as follows: wood fuel, mileage 23 miles per cord; with coal, 48 es per ton. With this report they sent a letter asking me how it was that e figures were so very far from my statements of our fuel consumption mileage. Upon analyzing the report, and figuring out the *actual* work e by the engines, I found that the report gave a very false impression—that correct figures were 27 miles per cord of wood, and 31 miles per ton of coal. se figures were within a mile of my statement. The question was ed, when I sent the report back with my explanation, "What was the use aving such statements at all, if they were not reliable and subject to veri- tion by actual tests?" The reason is obvious to every Master Mechanic: have no uniform method of obtaining results, and do not go about it in right way. We are inclined to take total figures because we have no e to go into actual figures, and sometimes know no more about our own s than any other. We get the results—divide them into certain sections. se statements are made in total, and we are in no position to make a just parison. The work of engines should be divided into passenger and freight fic, construction and switching service. It is miles per hour per engine t we want. Some of the switching engines stand by half the time doing hing, and they get as much mileage as if they had been hard at work. fuel they burn is about one-third or one-half as much as an engine would n drawing a freight train. It is the failure to take these things into unt that enables some roads to show better results than those of better des and capable of greater economy. By giving the real figures of work e, as I have suggested, recording mileage made per ton of coal and per l of wood per mile run, these errors can be obviated altogether, and we ll be able to institute a comparison between the several kinds of fuel on a basis. We must also consider in connection with this question the antages of boiler construction, and the means employed in different ines to attain the greatest economy of fuel. There are many patents for ning coal fuel—some of them valuable, some worthless. As a rule they of not much account. It has been said, I think truly, that the most eco- ical results can be obtained in coal burning by careful firing. It is of utmost importance that this Convention impress upon engineers the antages of a little care in making and keeping up their fires. I have ten to twenty different railroads in Europe during the last three months, as many in this country, in regard to this matter, selecting those roads

which were the heaviest coal consumers, and the general agreement is that the best results in coal consumption are obtained by careful stoking. Experience will establish the fact, I believe, that the most simple boiler is the most economical if you have a careful fireman. One thing I have noticed in my investigation is that the smoke boxes as used in America are too small, as a rule. In Europe, by which I mean England, Ireland, Scotland, and France, the smoke boxes of engines are from thirty to fifty per cent. larger than those used in America. You fill your smoke box with petticoat pipes, steam pipes, and blast pipes, and when you come to open the door there is no room to get inside it. The smoke boxes in Europe have room enough to allow two men to work inside them easily. The size of the smoke box has much to do with the perfect combustion of your fuel. The smaller the box the duller the fire. With a large smoke box the admission of a large quantity of air to the fire makes the coals dance and keeps the fuel in more thorough combustion. The smoke box acts upon the fire as an air vessel upon the pump—the larger it is, within a reasonable limit, the more benefit you get of your fuel. It is well known to most of you, no doubt, that in Europe they have no obstructions in their smoke stacks—they use no cone. As an experiment, some little time ago, I took one of our smoke stacks off, and substituted a plain straight pipe of sheet iron. I do not know whether you will believe it or not, but it made a difference of between ten and fifteen per cent. in the consumption of fuel in favor of the pipe. The removal of the back pressure upon the piston, and the free discharge of steam with the simple smoke stack, made the difference. You will see that the obstructions in our smoke stack and smoke box make us suffer in our fuel consumption. The reason we can not use a simple open smoke stack is, of course, their discharge of cinders; but if we had a larger smoke box I believe we could use this stack. I will ask whether any gentleman here has tried the difference between large and small smoke boxes?

Mr. Flynn, Western & Atlanta Railroad—I can give no information on the subject before the house, but as a young member I would like to know what steps have ever been taken toward a uniform system of reports by all the Master Mechanics belonging to this Association.

The President—I will say, for the information of the gentleman, that at the Third Annual Convention of the Association, we adopted a report, or a uniform system of locomotive reports, which will be found on the 122d page of the Third Annual Report.

Secretary Setchel—Mr. President, I will state in answer to Mr. Robinson, that at the last meeting of the Association the Secretary was instructed to transmit to the Superintendent's Association a copy of the resolution passed by this body, in regard to the mileage to be allowed to switching and local freight train engines, and ask that it or a similar arrangement be adopted in order to secure uniformity in locomotive reports. I have done

so; and their Secretary informed me that the matter will be referred to the committee on that subject at their meeting in New York to-day, and if it should be reported upon immediately and adopted it will secure the desired object, and, I believe with Mr. Robinson, will obviate all difficulty in regard to a comparison of performance sheets so far as fuel is concerned.

Mr. FRY, Grand Trunk Railroad—Mr. President, while on this subject, I should like to ask one question of those who have had experience, and that is in regard to the action of the particles of coal on the tubes of an engine. A few months ago I visited several large shops in this country, and asked the question of various Master Mechanics. They told me several times that the action is apparently mechanical—that the tubes are worn out apparently by the coals passing up through them. I would like to ask whether any members of this Association have noticed that fact. I think it is a fact that iron tubes wear out sooner than brass. The brass seems to stand the action of the fire better than iron. It is considered by many that the fire box and tubes are worn out by chemical action—by the intense heat; but if the action is mechanical and not chemical, it is evident that steel fire boxes and tubes would be better than either iron or brass. Now in Europe, I believe, they use copper altogether for tubes and fire boxes.

Mr. WHITE, Evansville & Crawfordsville Railroad—Mr. President, in regard to the action of particles of coal upon fire boxes and tubes, I can say, in answer to Mr. Fry's question, that I have used copper fire boxes for a number of years on coal roads—fire boxes all copper, and flues also copper. When I went from the wood-burning road with which I was connected to a coal-burning road, I had occasion to take out a set of flues and had them pieced. I noticed they were very light, and doubted the propriety of piecing them. I had not been accustomed to burning coal and hated to renew them, so I let them be pieced. It did not pay for the work, and I never did it again. I found that the particles from the coal would scour the tubes out in the course of a year useless for piecing. I did not pretend to repair them at all. The fire boxes scoured out the same way. I find that comparatively large fire boxes run better than small ones—burn the fuel better and last longer. Recently we have been converting wood-burning engines into coal. At first we did not enlarge the smoke boxes, but the engines did not work satisfactorily with the old smoke boxes and we enlarged them. Since then they have done better. There is this about it; there is no doubt the smoke box acts as a sort of air chamber, and that the suction derived from the flues is more uniform when the box is large, and the exhaust does not jerk the fire. The air passes through moderately and regularly, and the particles remain in the fire until they are consumed.

Mr. ELLIOTT, Ohio & Mississippi Railroad—It appears to me that this

question hinges upon the quality and kind of fuel used. I do not believe any rule can be laid down in this matter where there is such a variety of fuel used all over the country. In some instances the large smoke box may be desirable where you require a soft blast; some engines require a soft, others a sharp, blast. Where you are compelled to use spark arresters a small smoke box is required and a sharper blast is needed. Unless we take into consideration the fuel, I do not think we shall arrive at any definite conclusion in regard to the size of fire boxes. On the road with which I am connected we use a light fuel; the finer portions pass off with the blast without consuming. With the fine coal it is necessary to use a spark arrester. Where you have a heavy coal to throw into the fire box a softer blast is needed, and the coal has no tendency to leave the box. I have had some little experience in the size of smoke boxes, and I find considerable importance in the arrangement of the petticoat pipe and the height of the exhaust in burning coal. A great deal, in my opinion, depends on the proper adjustment of these, so far as the steaming of the engine is concerned.

Mr. EDDY, Boston & Albany Railroad—Mr. President, it is my opinion that brass tubes are the kind to use for good service in making steam, and for long wear. I do not think the action of the particles of coal will wear them out as fast as copper or iron if you get them of the right size. They ought not to be more than No. 13 or 14. I have supervised the building of something like a hundred engines, and put in No. 11 brass tubes; I like them better than No. 10. They were better than any others I ever tried; they last longer and make steam quicker. As to the size of smoke boxes, I think they should be larger than in most cases except for wood-burning engines, in which they should be small. At the same time I think the adjustment of the exhaust and petticoat pipes is of more consequence than the size of the smoke box.

Mr. COLEMAN SELLERS, of Philadelphia—Some of the members of the Association are no doubt familiar with the recent Tilghman experiments on different kinds of metal with a sand blast of steam or air. Those experiments have shown that metal can be cut off at certain angles by means of this blast; and, also, that the effects of the impingement are greater on copper than on iron and steel. They show that copper is poorly adapted to the uses of locomotive tubes, as it can not resist the scouring action which has already been mentioned.

Mr. FRY, Grand Trunk Railroad—Mr. President, the question on our road has been whether it would be cheaper to burn coal than wood; and if so, how much? Of course this repairing and replacing of tubes by coal consumption must figure in the expense of burning coal; and it seems to me, from what I have heard, that such expense would be considerable.

Mr. EDDY, Boston & Albany Railroad—I would like to ask whether

any Master Mechanic here knows or has heard of a brass tube, No. 11, Stubbs' gauge, having worn out?

Mr. GORMAN, Toledo, Wabash & Western Railroad—I will state that when we first commenced burning coal on our road we had some engines from the Rogers' Locomotive Works, with tubes about No. 11, not brass but copper—good heavy tubes. We tried these tubes from eight to ten months, when they commenced bursting. I took some of them out, and found some of them were worn in places as thin as paper. We were obliged to take all of the tubes out. Since then we have been using iron flues altogether.

Mr. EDDY, Boston & Albany Railroad—I can only say that my experience is that brass tubes of the proper thickness will last longer than any others. We have put them into engines going to Cuba as thick as Nos. 9 and 10, and never put them in any engines less than 11 or 13.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—Mr. President, I think the difference between a light tube and a heavy tube is only a question of time, if there is any wear at all by the action of the coal. If it will wear out a thin tube it will wear out a thick one also. I know that some years ago, when it was the custom to use copper in the fire boxes altogether, that it was found that after a while in using coal, in about twelve or eighteen months, the sheets of the sides immediately in contact with the coal were worn through. I have seen sheets not more than the one-sixteenth of an inch thick where they were originally half an inch, and in some cases five-eighths of an inch. In those places where the coal did not come in contact with the sheets they seemed to be as good after eighteen months or two years as they were in the first place. The action of the coal does wear the material out; there's no mistake about that.

Mr. EDDY, Boston & Albany Railroad—Mr. President, my question remains unanswered as yet. I think it is important to all railroads to know whether brass tubes will wear out in this extremely short time. It seems to me that gentlemen here ought to know whether brass tubes of the thickness I have mentioned have worn out or not—that is, if they have been given a proper trial.

Mr. N. H. SPRAGUE, of Pittsburgh—Mr. President, may I ask the gentleman how long his road has been using brass tubes with coal-burning engines?

Mr. EDDY, Boston & Albany Railroad—I do not know that I can tell the gentleman how long we have been using brass tubes—a number of years though. Our road is not the oldest coal-burning road in the country; that is why I asked the question.

Mr. ROBINSON, Great Western Railroad—There is no question that brass tubes are better for coal-burning engines than iron, so far as fuel goes. Brass tubes last half as long as the life of an engine, and I do not think we

will get iron tubes to last longer. Of course the original cost of tl more, but they save fuel by taking heat much more rapidly, and t advantage which more than counterbalances the higher cost. On which I represent we have had to clean and scrub the iron tubes years, while it is only necessary with brass ones every three or f which makes a great saving in time and labor. In Europe brass from six to seven years, during which time they need new ends ı box, when they are good for three years more. In regard to the us arresters they are, of course, a necessity in this country where so m coal is used. If we could get lump coal then there would be no sı sity; for spark arresters require a sharp blast in the engine, and l the obstructive appliances in the smoke box. In order to get m the fire and to facilitate combustion of the fuel, I tried running our engines with the furnace door open. That, however, throws ba which prevents the engineer from getting the best view of his tra therefore impracticable in this country where we all run with cabs thought of a projected fire door at the top of the furnace in additi door for fuel, and mean to try how it will work. I would suggest, i tion with this subject, that the Committee having this question request information as to what are the proportions and areas of sm tubes, and fire grates used, and, as I have before said, I hope M chanics will be requested to divide fuel sheets in three divisions— freight, piloting and switching service—giving us, as results, miles cord of wood and ton of coal.

Mr. FRY, Grand Trunk Railroad—Mr. President, I would like my thanks to Mr. Eddy and Mr. Robinson for the light they have on brass tubes. In considering the economy of burning coal we ha take into account the expense of brass tubes. I was led to believe tubes wore out in a very short time, and knew that iron tubes w longer in taking heat, and therefore consumed more fuel in p I can now tell our company that two Master Mechanics who experience tell me brass tubes can be economically used on coa engines.

Mr. EDDY, Boston & Albany Railroad—I would like to make or on the subject of iron tubes taking heat and making steam. I have considerable experience with brass, iron, and copper tubes, and I mus all my preference for brass tubes, that so far as my experience g am capable of judging, brass tubes will make steam quicker than e or copper.

Mr. DURGIN, of Pittsburgh—I would like to ask whether any of ter Mechanics here have had any experience with steel tubes?

Mr. HUDSON, Rogers' Locomotive Works—I understand the Per Central Railroad have had some experience in the use of steel tı

built a lot of locomotives and put steel tubes in them, but I can not speak of their use.

Mr. DURGIN, of Pittsburgh—I think Mr. Boone has had some experience with steel tubes; perhaps he will tell us what he knows about them?

Mr. BOONE, Pittsburgh, Fort Wayne & Chicago Railroad—As long as steel tubes remain in when first set, I can say they give good results and are good for steaming purposes; but when taken out and replaced with new ends it difficult to get the ends to stay. They run three or five days and break off—repair them again they run eight or ten days and are broken off again. I would have no more steel tubes if I had my way in the matter.

Mr. LOSEY, Michigan Central Railroad—It seems to me that this question of economy in fuel depends on what section of the country you are in—whether a coal or a wood country. Now, we are burning coal in a wood country. We can buy wood for a dollar and seventy-five cents a cord, and we pay three dollars for a ton of coal. The life of a fire box with us, whether copper or iron, is three years; we have had some of them give out in one year. With wood we can run them ten and fifteen years without any trouble. Coal is a very heavy expense to us in the way of repairs. I can not find a fire box that has been put in within the last three years that has not gone to pieces, and those of engines not eighteen months old have been totally destroyed, and have had to be renewed entirely. With wood burners we can run them five, ten, and fifteen years without any renewal. I would like to know whether there is any economy in burning coal—any saving resulting from coal-burning appliances—under the circumstances I have mentioned.

Mr. C. T. HAM, of Rochester—What is your company's idea in burning soft coal instead of wood, when wood is so cheap and coal so expensive, both in furnace and on machinery?

Mr. LOSEY, Michigan Central Railroad—I can not explain that.

Mr. HAM, of Rochester—Is it not because the excess of business on the line does not give you time to gather up the wood?

Mr. LOSEY, Michigan Central Railroad—That may be so.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I move that the discussion of this subject be now closed.

Carried.

Mr. SETCHEL, Little Miami Railroad—Mr. President, I desire at this time to move a reconsideration of the vote by which this Convention yesterday accepted the invitation to the banquet at New York.

Mr. MORRIS SELLERS, of Pittsburgh—The gentleman has taken the motion out of my mouth. I desire to say, Mr. President, that when I made the motion I did yesterday, it was from the best of motives. I knew there were many gentlemen here who were anxious to see Gettysburg, and many

others who designed attending the New York banquet. I made the motion to enable all parties to get to the banquet in time, giving those who so desired an opportunity to go to Gettysburg. I do not want to be considered as officiously forcing the Convention to go to either place, and I move a reconsideration in order to give the Convention another chance to arrange its own programme.

Mr. SETCHEL, Little Miami Railroad—My motion is, Mr. President, to reconsider the vote by which this Association agreed to go to Gettysburg and accepted the invitation to the New York banquet.

Mr. SELLERS, of Pittsburgh—That is not the motion as it was put yesterday.

Mr. SETCHEL, Little Miami Railroad—Then, Mr. President, I move a reconsideration of the vote by which the amendment to the Committee's report, agreeing to go to New York by the way of Gettysburg be reconsidered.

The motion was carried.

Mr. SETCHEL, Little Miami Railroad—Now, Mr. President, I hope that wherever we may decide as individuals to go, whatever invitations we may accept, that no invitations will be discussed or accepted in open Convention. We come here for the transaction of business, and our public discussions should be on business matters only.

THE PRESIDENT—The Constitution provides, I think, that the discussions on all subjects shall be in open session.

Mr. SETCHEL, Little Miami Railroad—Then I would move that all consideration of these invitations be dropped at this meeting—that is the invitations to the New York banquet.

Mr. MORRIS SELLERS, of Pittsburgh—Mr. President, I was anxious to have this reconsideration take place, so that we might all come to an understanding. I made the motion I did yesterday because I found there were a good many members of the Association who wanted to visit Gettysburg and go to New York also. I did not want, nor did I expect, to influence the Convention one way or the other. I do not want to meet members of the Association and personal friends and have them say I am wrong, or to think myself that they are wrong. I want the Convention by a full vote to say what they want to do—I want each man to say what he is going to do. In regard to the New York banquet, I would say that our friends there have been at great trouble and expense to prepare an entertainment for us, and I hope the Convention will be a little careful in refusing their hospitality. At the same time I don't want it said that I or anybody else tried to take the members away from here to New York. Let the Convention say just what it wants.

Mr. SETCHEL, Little Miami Railroad—Mr. President, I desire our New

distinctly to understand that so far as I am concerned I am in
embers of this Association, as individuals, accepting their hos-
I do not think we should mix business and pleasure up in this
nd I therefore regard the acceptance of invitations to banquets,
eral body, as out of the regular order of business We have been
too great a fondness for mixing pleasure excursions with our
and I desire to repel that charge now and here. The discus-
matters puts the Association in a false and by no means favor-
d I hope there will be no notice taken of this discussion by the
. Let the members go to New York and partake of the hospi-
l there, if they see fit, but let us not adopt any resolution com-
to go there. A motion for the Convention to go anywhere, or
ccept any hospitalities after the Convention has adjourned, is
n my opinion.

ON, Great Western Railroad—I do not see what harm is to be
ting the invitation to the New York banquet. Its acceptance
to go unless he so desires. It is plain that there are some who
d others who do not. Let those go who wish to go, and there
ficulty with those who do not. There is no real necessity for
you take it that way.

UE, of Pittsburgh—So far as Mr. Sellers is concerned I do not
it to take any blame to himself for the action of the Conven-
ing his amendment to the Committee's report yesterday. It
hat he was only trying to accommodate members and to utilize

T, Ohio & Mississippi Railroad—I move, Mr. President, that
hich the amendment to the report of the Committee on Cor-
agreeing to go to New York by the way of Gettysburg, be

was carried, when the amendment was put to vote and lost.

T, Ohio & Mississippi Railroad—I now move that the report
ittee as originally presented be adopted.

was carried.

ELL, Little Miami Railroad—I move a reconsideration of the
the report of the Committee was adopted.

was lost.

IDENT—The next business in order will be the report of the
the Construction, Operation, and Costs of Maintaining Con-
Brakes. I will state that, at the last meeting, a slight confu-
cts led to the appointment of a similar Committee on Com-
es. In consequence we have reports from both Committees.

Report of Committee on the Construction, Operation, and Cost of Maintaining Continuous Train Brakes.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee on "The Construction, Operation, and Cost of Maintaining Continuous Train Brakes," beg leave to report that they issued circulars containing the following questions:

1st. Have you any continuous train brakes on your road? If so, describe the construction of them.

2d. How are they operated? If by the engineer, do you believe he should operate the train brake?

3d. What is the effect of the coupling breaking and train parting with continuous brake? and what signals or other precautions have you to prevent accidents from this cause?

4th. What is the cost of applying the continuous brake to your engines and cars?

5th. What is the cost of keeping the brake in working order?

6th. Do you find the cost of repairs of cars to be greater or less after you adopted the continuous brake? If any difference, what is it?

7th. Have you as many detentions of trains and accidents from brake beams breaking, brake rods and connections giving way with the continuous brake, as you had with the old hand brakes?

8th. Do you employ as many brakemen on the trains with the continuous brake as you had with the old hand brakes? If not, what is the difference in wages?

9th. Do you apply the continuous brake to the whole train, including tender? If not, why not?

10th. Do you use the brake for all stops, or only in case of accidents?

11th. Please state fully all defects of construction and operation you have discovered in the brake, and what in your opinion is necessary to perfect it?

In answer to these questions we have received replies from twenty-

ır Master Mechanics; of these, thirteen report they are using ; Westinghouse Air Brake, eleven report the old hand brake use.

Mr. Johann, of the Canada Southern Railroad, mentions having ed the Goodall Steam Brake with the Westinghouse. The ›odall brake being a continuous brake, similar in construction to e Westinghouse, steam being used instead of air, both being oper-ed by the engineer. The cost of the two brakes is about the same, e Goodall costing more to keep it in repair. The Westinghouse ever gave trouble—always worked well; the steam brake gave con-ant trouble by condensing of steam—would not work effectively, ie hose connections between cars constantly giving out.

Mr. Peddle, of the Terre Haute & Indianapolis Railroad, also akes mention of using the Westinghouse brake, and on two of his ngines a brake of his own plan, which he describes as follows:

"The air pressure is obtained by reversing the engine and pumping he air in through the exhaust openings by the ordinary steam cylin-er, and storing the air in a reservoir for use; the exhaust pipes are losed by valves, and an opening made into the atmosphere for the dmission of pure air when the engine is reversed; this opening is losed by a check valve when the engine is performing its usual uty. One advantage of this plan is that the engine itself is retarded hen the brake is applied; but no injurious pressure can be got up n the cylinder or pipes, as a safety valve in the reservoir relieves he pressure when it exceeds seventy pounds. The cylinders under he cars are vertical, and the pistons lift when the pressure is intro-uced, and the weight of the piston assists in relieving the brake hen the air is exhausted."

The Westinghouse brake is operated by a cock, and the Peddle rake by the engine being reversed and by a cock same as the West-nghouse. The cost of applying the Peddle brake is about one-half f the Westinghouse.

This brake and the Goodall brake, mentioned by Mr. Johann, are he only brakes, other than the Westinghouse, that your Committee ave received any report from.

It is the opinion of all the Master Mechanics that the engineer hould operate the train brake.

Seven Master Mechanics report that their roads have signals to prevent accidents from "coupling breaking and train parting." Six Master Mechanics report their roads as not having provided for an accident of this kind. If the coupling gives way from the brake being applied, it is generally caused by the application being too sudden, or too strong a head of air being admitted at once, the brake taking hold of the last car first. If the coupling is slack they are likely to break. When this occurs from applying the brake, the brake will remain on the detached part and the cars will stop without any damage. The danger with an air-brake train is when the train breaks while in motion. The bell cord as it breaks will strike the signal bell one tap (this on many roads is the signal to stop). Should the engineer apply the brakes and stop, the rear section would run into the first and damage ensue. This may be avoided by making the bell signal one tap to start, and while in motion two taps to stop. Should the bell tap once the engineer does not apply the air brake, but whistles for the brakemen to set the hand brakes and the rear section is stopped.

The Westinghouse Air Brake Company have lately made improvements which will overcome the danger from trains parting. They have it so arranged that the brake can be applied from any car of the train without the aid of the engineer. If the train parts the brake is applied instantly to the detached cars as well as to those remaining with the engine.

The average cost of applying the air brake to one locomotive and tender is $375.00—to one car, $120.00; this includes machinery, pipes, coupling, material, and labor in fitting it up.

One Master Mechanic reports the cost of "keeping the brake in working order" twenty-five cents per train per day; another reports five dollars per engine and car per month. Mr. Peddle reports the cost of keeping the air brake in order on ten engines for one year $667.28, or $44.48 per engine; and on cars $691.35 per year, or $14.04 per car. Mr. Boone, of the Pittsburgh, Fort Wayne & Chicago Railroad, reports the cost of keeping the air brake in order on thirty locomotives for one year is $936.00, or $31.20 per engine; and per car for one year fifty-four cents. The $31.20 per engine includes all repairs, whether caused by accident or wear of machinery.

Three Master Mechanics report that they see no difference in the cost of repairs of cars after adopting the air brake." Ten Master [M]echanics report that they find a marked reduction in the cost of [re]pairs of cars; five of these report that the item of wheels is much [le]ss than with the old hand brake. Mr. Wells, of the Jeffersonville, [M]adison & Indianapolis Railroad, reports that there is a saving of at [le]ast twenty-five per cent. in wheels. Mr. Boone says, "At the [m]eeting in Boston, there was considerable difference in opinion in [re]ference to the wear of wheels with and without the air brake." He [(]Mr. Boone) has investigated the matter again in the working on [P]ittsburgh, Fort Wayne & Chicago Railroad, Western Division, and [fi]nds the number of defective wheels (in the last year, 1869, when [th]e old hand brakes were used) to have been one hundred and [ei]ghty-one; the cost of new wheels to replace these, labor of fitting [u]p and changing in truck, after deducting the value of defective [w]heels, was $4,078.50. Last year, 1872, with the passenger stock [eq]uipped with the air brake, the number of defective wheels was [th]irty-six; new wheels to replace these, including cost of fitting up, [la]bor of changing, and crediting the value of defective wheels, cost [$]608.40—showing that the wheels cost $3,470.10 more in one [ye]ar without the air brake than they did with it. The wheels in [b]oth years were from the same foundry, "Ramapo," and the cars and [ro]ad in equally good condition. The only difference is, in 1869 [th]ere were only three twelve-wheel sleeping coaches and five twelve-[w]heel passenger coaches on the line, while in 1872 there were thirty [tw]elve-wheel sleeping coaches and thirty-five twelve-wheel passenger [co]aches. In 1872 the speed of the trains was greater, the cars heav[ie]r, and more of them in service.

Two Master Mechanics report that they see no difference in the [n]umber of "detentions of trains or accidents from brake beams [b]reaking, brake rods and connections giving way," since they used [th]e air brake. Eleven Master Mechanics report that this class of [ac]cidents and detentions have almost ceased since they used the air [br]akes.

Four Master Mechanics report that they employ as many brake[me]n as with the old hand brakes. Nine Master Mechanics report

that they use one brakeman less to each passenger train, reducing the expense of brakemen on passenger trains one-third.

Three Master Mechanics report that they use the brake on the whole train except the tender. Ten Master Mechanics report using the brake on the whole train, tender included. There is a difference of opinion why it should not be applied to tender. One gentleman thinks "it should not be so applied when the brake is on the trucks, as it sets the brake on the tender first, and very severe, as the tenders are loaded heavy;" another "does not consider it necessary to apply to tender, as the brakes on coaches are sufficient;" a third gives as a reason "the difficulty of adjusting the brakes for a loaded and partly loaded tender, thinks the effect on the wheels bad."

All using the air brake report that it is used for all stops. Three report they have discovered no defects in the brake. The remaining ten complain of the pump, complication of the machinery, and the brake not releasing quick enough. The defect reported in the pump is that the valve arrangement becomes deranged.

This question of brakes was so thoroughly discussed at our last meeting that your Committee find it difficult to make a report that will not be a repetition. The danger of the brake not working when needed, also the danger from train breaking into sections while running, has been provided for by keeping the hand connection to the brakes in good order, and keeping two brakemen on (who also keep up fires, attend to lights, and the usual business) train, who, when the engineer whistles for stations or any point where a stop is to be made, go to the hand brakes and remain ready; in case the brake fails the hand brakes will be applied; they are also used to stop the rear section of train in case of coupling giving way, as described above. Your Committee have no report of failure of the brakes to do their work.

Your Committee are of the opinion, from information gathered from reports, that the saving from repairs of cars, repairs of brake gearing, and from wheels, will pay the expense of fitting on the brakes to engines and cars; and that the saving in wages in dispensing with one-third of the brakemen will more than pay for keeping up the repairs after the brake is fitted on—this taking dollars-and-

cents-view of the matter—without taking into consideration the increased safety and increased comfort of the passengers, all of which are too fully known to make further mention necessary.

Your Committee are not prepared to admit that the objection to using the brake on tender is valid. If a variation of load is an objection on a tender it is equally so on a coach, as the coach one day may be loaded to its full capacity and next day empty. Your Committee believe the question to be one simply of leverage, which should be so adjusted as not to slip the wheels regardless of load, and a fixed pressure of air, which is now obtained by a valve on the reservoir. There is no question but that the air brake will slip wheels if the leverage is not properly adjusted to it very effectually, at the same time it can be easily avoided and the brake effective.

At our last meeting several reported they did not use the brakes for railroad crossings, drawbridges, etc. All who have reported to your Committee say they use it for all stops, from which we are of the opinion that the brake is growing in favor and more confidence placed in it.

The defects reported in valve of pump and check valve breaking, is sometimes caused by running the pump at too great a speed. This is almost always the case with new engineers unaccustomed to its management; also in a disposition of the engineer to adjust the valve. Some of your Committee have found considerable trouble from this cause—when a man was on the engine who would let it alone then it would cause but little trouble.

Your Committee are led to believe that much of the complaint of the machine being complicated arises from the fact that it is a new thing, which we have not as yet become familiar with. We never hear any complaint of the link motion on our locomotives being complicated, because we have been working with it for years; yet, when we examine into and analyze it, the link motion will be found to be far more complicated than the air brake. Continuous air brakes are a new thing, defects are to be expected, and no doubt can be remedied.

The delay of releasing the brake can be avoided by releasing part of the air after the momentum of the train is stopped, leaving just air enough to hold the brakes to the wheels until a full stop is made. Your Committee are of the opinion that there is not as much delay

in releasing the brakes with the continuous brake as there was with the old hand brakes. Then each brakeman set up the brakes on two cars; he would let one off, and then step on the second car and let the brake off of that; doing this would take fully as long as for the air to leave the pipes. It also frequently happened with the hand brake that they would become fast, and the brakes could not be let off until the brakeman had assistance.

All of which is respectfully submitted,

JAMES M. BOONE,
P., Ft. W. & C. R. R.
W. S. HUDSON,
J. JOHANN,
C. & C. S. R. R.
} *Committee.*

Report of Committee on the Application of Compression Brakes.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, reappointed at our last Convention to report on the Application of Compression Brakes, beg leave to state that we have received replies to our circular of questions respecting this subject from twenty roads. Last year we received replies from thirty-three roads; and, in view of the falling off this year in the number of replies received, the information embodied herein is probably not as full and interesting to the Association as the report for 1872.

Many of our members having probably little, if any, further experience on this subject during the past year, have therefore, no doubt, thought a reiteration of their experience and opinions as expressed at that time unnecessary; your Committee therefore would here suggest the necessity of replying to each year's inquiries, though the experience and observations may not materially differ from those previously given.

The synopsis, in tabular form added hereto, shows almost all the information received in a concise and easily understood manner; the remaining information, which is the individual experience of members having compression brakes under their charge, and refers more particularly to their working economy, etc., will state as follows:

Mr. Peeples, of the Central Railroad of New Jersey, says: They are using the American Vacuum Brake, and are applying it to all

heir passenger equipment as fast as they can do so. One case has een reported whereby a rear end collision was prevented by the rompt use of this brake; and, for the time they have had it in use, hey estimate a saving of twenty per cent. in brake shoes and wheels. It is his opinion, that a good reliable power brake under the entire control of engineer, in connection with a good signal ell on the engine under control of the conductor, is the best form f brake yet devised; of course retaining the ordinary hand brake n complete working order with brakemen ready at their posts.

Mr. Lamb, Des Moines Valley Railroad, says: The Westinghouse Air Brake, with which their passenger and baggage cars are quipped, paid for itself during the first month they used it in the aving of cattle and horses—their road not being fenced. Thinks it probably harder on wheels, though so little as to be hardly worth mentioning.

Mr. Peddle, Vandalia Railroad, states that they have in use the Westinghouse Air Brake, also another brake similar in its application to the cars, but in which the air is compressed by the steam ylinder, instead of a separate compresser, but does not state the ame or inventor of this latter brake, nor to which of the two the ollowing information refers: He says several accidents have been revented, and cites a case where a severe front collision between a reight and a passenger train was avoided; the result being merely he destruction of the pilots of both engines, and thinks that with he hand brake only a serious loss of both life and property in all robability would have occurred.

Mr. Sanford Keeler, of the Flint & Pere Marquette Railroad, who as had the Westinghouse Air Brake in use about two years, nows of many cases where it has been the means of saving property and probably the lives of passengers, and have not yet had a ase wherein it has failed to work. With reference to wear of wheels, e says: "We have not yet changed or had a flat wheel on any car quipped with this brake. Previous to its adoption we were annoyed ith flat wheels, and I think it has saved the company the cost of e entire outfit in the saving of wheels alone."

Mr. Johann, of the Chicago & Canada Southern Railroad, states

that they will equip soon with the Westinghouse Air Brake; has experimented with and used the Goodall Steam Brake, but found it unreliable, as the steam condensed as it passed through the pipes, virtually giving no power in the rear part of train, and therefore abandoned it.

In giving the experience and opinions of members of this Association who have replied to our circular on "Compression Brakes," your Committee would also state in connection therewith that very satisfactory public tests have been made with the Westinghouse Air Brake and Smith's American Vacuum Brake, but not being in possession of official information your Committee do not deem themselves authorized to here give the reported results of these experiments.

The question of *brakes* is one of paramount importance, not only to the railroad corporations of our country, but one in which the whole people are also interested, and ought not to be lost sight of by this Association.

As the practical use and experiment with power brakes is steadily increasing, we may reasonably expect that many improvements in their structure and utility can and will be made in the future.

Respectfully submitting this report,

CHAS. GRAHAM, *M. M. L. & B. R. R.*
C. B. STREET, *M. M. Penna. R. R.*
} *Committee.*

Mr. WHITE, Evansville and Crawfordsville Railroad—I move the acceptance of both reports.

Carried.

A MEMBER—I would ask the President whether the by-laws make any provision in regard to the length of our sessions?

THE PRESIDENT—The by-laws provide that our daily sessions shall be held from 9 o'clock A. M. until 2 o'clock P. M.

A MEMBER—Then I move that when this Convention adjourn *sine die* it do so at 2 o'clock P. M. on the 17th of May, 1873.

Motion lost.

THE PRESIDENT—The Finance Committee are ready to make a report. It will be read by the Secretary previous to the discussion on the subject of Compression Brakes.

Report of Finance Committee.

can Railway Master Mechanics' Association:

IEN—The Committee appointed to Examine the Accounts surer and Secretary for the year 1872, find them correct, iend an assessment of ten dollars to be made on each the M. M. A., for the purpose of defraying the expenses nt year.

F. A. WAIT,
JOSEPH KELLY, } *Committee.*
J. VAN VETCHEN,

', Michigan Central Railroad—I move the report be accepted.

', Michigan Central Railroad—I also move that a committee of ointed to collect the dues from members at this meeting.

n was carried, and the President appointed the temporary Fi- ittee to make the collections.

IN, of Pittsburgh—How much is the assessment to be?

IDENT—The amount fixed by the Committee is ten dollars.

ion on the reports of the Committees on Compression Brakes the President announced that the next business in order would of the Committee on the Relative Cost of Operating Roads of hree Feet Six Inches or Less, and those of the ordinary Four nd a half Inch Gauge.

ıg no report from the Committee, a paper submitted by W. W. ew York, by unanimous consent was read by the Secretary.

ər Submitted by W. W. Evans, of New York.

NEW YORK, May 12, 1873.

ETTE, Esq., AND OTHERS, *Committee of the Master Mechanics' appointed to Examine and Report on the Cost of Operating Roads of Three Feet Six Meters or Less, Compared with those of Four Feet One-half Inches:*

IEN—Want of time has prevented my answering the cir- ived from you some time since. I beg leave to send you ro pamphlets which I have published in reference to the ailway gauges, in which you will find my opinions as to of narrow-gauge railways, more particularly in reference

to their construction than the operating. The first pamphlet con tains letters written at the request of one of the chief officers of th British Government. The second is devoted chiefly to a review (the first pamphlet, by Benjamin H. Latrobe, the engineer that bui the Baltimore and Ohio Railway, who holds among engineers a hig position for great experience, ability, and calm, clear judgment. also contains the opinions of some of the leading engineers of En land, and the statistics and data collected by them.

I will now answer the questions in your circular *seriatem:*

1. I have not had any experience in operating railways of gaug of less than four feet eight and a half inches, but am intrusted an engineer in the construction of a number, and the constructi of the engines, cars, etc., to work them.

2. The cost of transport of goods on a railway will depend ve much on conditions and local circumstances, such as gradien curves, climate, distance, amounts to be carried, speed, etc. Th can be no doubt but that a light railway, with everything to c respond, and a light business to transact, can be used to a much b ter advantage than a railway built with heavy rails, engines, ca etc., on the same line to do the same work.

3. There are but few railways existing of different gauges whi can be compared as to the cost of transportation, with any degree accuracy, without first equating many different points connected wi this matter of cost. The advocates of the narrow gauge system ha undertaken to show the great merits of this system by holding the prosperity, dividends, and ratio of expenses to receipts, of t Festiniog Railway in Wales as an evidence. I have undertaken show in my pamphlet No. 2 that this is all a fallacy, growing out their dividing dividends on shares which represent less than half t cost of the railway, and also in charging very high rates for carryi goods. I also show that if our standard-gauge railways here were continue their charges for carrying per ton per mile, and were put the same expenses as the Festiniog Railway accounts show they we it would bankrupt all our leading railways.

4. Small cars for local traffic have their advantages on railwa where cars carrying small amounts have to be left at stations. F

through traffic, where the amounts are considerable, there can be no doubt of the economy in the use of large and long cars, having eight wheels and very little overhanging load; the trucks feel the inequalities of the track, but the body of the car and load does not. The four-wheeled car having much overhanging weight feels the inequalities of the track severely; the whole car, body and load, oscillates in the direction of its length, rendering useless a portion of the tractive power of the engine. There appears to be good reason to believe that narrow-gauge tracks will be more difficult to keep true to grade and line than tracks of the standard gauge, as it will be impossible to keep the center of gravity of engines as low in proportion to gauge for a narrow as for a standard-gauge line. This being the case, and the sleepers of the narrow gauge being shorter, the lateral oscillations of engines will tell with more force on the track to throw it out of level and line.

5. The difference in weight of covered cars of equal floor area, if properly proportioned, and for a fixed or miscellaneous business, will vary but little in gauges of three feet and four feet eight and a half inches. The standard house-car of 26 feet long by 8 feet wide has a floor area of 208 square feet. To get the same area a car for three-feet gauge must be, if six feet wide, 34⅔ feet long. This gives a length of sides and ends 13⅓ feet longer than for the 26 feet by 8 feet, and of course the house part for this car will be so much heavier to cover the same amount of goods, and the center of gravity of load will be higher if the car is filled and the cubic capacity the same. The longitudinal timbers being longer must be heavier; the transverse timbers may be lighter; the springs, buffers, wheels, pedestals, brakes, journal boxes, roof, floor, etc., will be the same. The axles being less for narrow gauge, and the frame of truck also, it must be recollected that while the twenty-four-inch wheel used for narrow gauge can be used as well on the standard gauge, the thirty-three-inch wheel used on standard gauge can not well be used on the narrow gauge.

6. Cars of like strength, to carry like loads at like speed on same sized wheels, will probably cost the same for narrow as for standard gauge.

7. The resistances met with in passing around curves is a matter

that has never been experimented on as fully as it ought to have been, with cars of different size and build, and at different speeds, on curves with different radii. A reliable dynamometer accurate and powerful enough to measure the tractive power exerted by engines in hauling heavy trains on different lines, is, I think, an instrument not yet invented. The resistances on curves may be divided into two kinds—the flange frictions and the frictions due to the difference between the length of inside and outside rails. The former is measured by the angle at which the flanch of the wheel strikes the curve, and is governed by the distance the axles of a car or a bogie are apart. If the axles of a bogie on standard gauge are four feet eight and a half inches apart, and the axles of a bogie on a three-feet gauge are three feet apart, the angle will be the same and the frictions should be the same for both gauges. The latter resistance, due to difference of length of rails on a curve, will on the narrow gauge be the least, theoretically; but I doubt if any engineman would notice it in hauling a train around a quadrant of a circle with 400 feet radius, for in the standard gauge the slip of the outside wheels will be 7.39 feet in a distance of 628.32 feet, and in the three-feet gauge the slip will be 4.81 feet in the same distance, the difference in the gauges in a quarter circle being only 2.58 feet.

8. After a diligent study of the subject I am perfectly convinced that a light narrow-gauge railway can not be operated any more economically than can a light standard-gauge railway. I find my opinion is confirmed by that of the most eminent and experienced railway engineers of all countries. The only advantage the narrow has over the standard-gauge railway is a slightly greater facility to traverse sharp curves, and also a slight economy in construction of roads, chiefly out of decreased top-width of embankments.

The disadvantages will be many, a few of which I beg to mention:

1. If the top-width of embankments is narrower it will not be as safe to run over.

2. If the center of gravity of engines and cars can not be kept as low in relation to gauge as it is on standard gauge, then they will not have the same stability, and can not be run at speed with the same safety.

3. Cars being longer to carry the same load as is carried in cars on standard gauge, the trains must be longer and more difficult to handle.

4. The trains being longer the curves will be traversed with more difficulty on curves of 200 feet radius (the curve so strongly advocated by narrow-minded, I beg pardon, by narrow-gauge engineers); it will require only 628 feet of train—not a long one—to occupy one-half of an entire circle, so that when an engine is hauling in one direction the last car of the train will be hauled in the opposite direction, resulting in very great flange frictions.

5. The trains being longer the sidings must be longer, and the movement of cars in stations while loading and unloading will be greater.

6. The cars being narrower they can not give the same accommodations to either man or beast that they have in the standard-gauge railways.

7. In the construction of engines, where considerable power is required, it is difficult to arrange the parts so as to obtain efficiency and safety, and keep the width and center of gravity down to reasonable limits, as I find by recent conversations with one of the most eminent locomotive engineers of this country, while devising ways and plans to build engines for a railway of two feet six inches gauge for Peru—a road on which there are two of the so-called Fairlie engines, which have failed to pull gross loads of thirty-one tons for seven miles up gradients of 52 to 104 feet per mile, without stopping twice to breathe and recuperate their powers, using in this distance 800 gallons of water and 1,600 pounds of coal (this data I received direct from the superintendent of the railway).

8. In working a system of railways, running in all directions, covering the face of a country, crossing and connecting with each other, until a perfect net-work is formed, uniformity of gauge is considered by all practical and far-seeing engineers of ability as a matter of the greatest importance. When the government in England decided to change the railway gauge in India from 5 feet 6 inches to 3 feet $3\frac{3}{8}$ inches, they having 4,600 miles of the former built, it was denounced by the most experienced and able engineers in England as a national calamity.

Recently a discussion on this gauge question has taken pla
before the Institution of Engineers in England. One of the Coun
of the Institution, writing to me, says:

"The discussion was a long one. The reply of Mr. Thornton, t
Secretary of the India Board, who introduced the discussion a
defended the Board in its change of gauge, was very feeble. Still
is a question how far the India Government, having made a fal
step, will be willing to 'swallow the leek' and retreat."

The advocates of narrow gauge appear to think that break
gauge, in its commercial aspects, is measured entirely by the cost
taking a ton from one car and putting it on another; they forg
that time is money, that while the cargo of a train is being tran
ferred from one set of cars to another it might be forwarded thirty
fifty miles further to its destination; also, that in working a syste
of railways where changes of gauge occur and a large amount of bus
ness is being transacted, a much larger amount of rolling stock w
be required than would be the case if all were of one gauge. Th
forget that in the transfer of goods there is much damage often don
that if more rolling stock is required there must be more standi
room for cars and engines, and more and larger store houses, for
can not always be arranged to have a train on one gauge ready
receive the cargo on a train on another. They forget all but th
advocacy of a "hobby," their support of a toy, their reasoni
against reason, and their power to make broad assertions that ha
not and can not be proved by either theory or fact. Some of the
assertions are not governed by common sense, for recently a writ
in a paper in California says he is ready to prove that the surve
can be made and fences can be built for a narrow-gauge railw
cheaper than they can be for a standard-gauge railway.

Did the narow-gauge advocates ever stop to think that in t
dawn of railway enterprise, when it became a matter for the world
take an interest in—I mean in the days of that great man, Geor
Stephenson, that they had in England railway tracks of many diff
ent gauges, and some of the cleverest mechanical minds that ev
existed, but none of them ever thought of or advocated any oth
gauge but the standard—the common-sense gauge—the gauge th

suits the standard height, weight, and strength of man, and s him, as well as cattle and horses, and bales and boxes of goods, best and most convenient accommodation.

he convenience of this gauge was established long before the ray era. It was probably established when wheeled vehicles were introduced for the use of man. It was in use nearly two thou- years ago, as shown by the ruts in the stone pavements of the ts of Herculaneum and Pompeii. Did the narrow-gauge advo- ever know that the first railway built in Austria, promoted and nized by government, was a narrow gauge? Then they soon d out the fallacy of it, and since then there has been nothing seen of narrow gauge in Austria.

n officer of Sweden, connected with their railway system, writes n indignant terms to correct the idea I had that they, like Nor- had adopted the narrow gauge. He gives me to believe that neither believe in or wish to have narrow-gauge railways.

xcusing myself for having written much more than I intended nd begging you to cross out such portions as may not be con- red relevant to the questions asked, I remain, gentlemen,

Your obedient servant,

W. W. EVANS,

Associate Member Master Mechanics' Association.

r. KEELER, Flint & Pere Marquette Railroad—I move the paper of Mr. ns be received.

arried.

r. FORNEY, Railroad Gazette—I move the Secretary read the circular out in regard to narrow-gauge railroads.

he motion was carried, and the Secretary read the circular as requested.

Circular of Committee.

he Committee appointed at the last Annual Convention of the erican Railway Master Mechanics' Association, to report upon he *Relative Cost of Operating Roads of Gauges of Three Feet Six es, or Less, and those of the Ordinary Four Feet Eight and a f Inch Gauge*, respectfully submit the following inquiries, with

the request that you will send replies thereto as early as
with any additional information relative to the subject whi
be able to give:

1. Have you had any experience in operating railroads of gau
than four feet eight and a half inches?

2. If so, have you observed any material difference in the c
porting any given amount of freight or number of passengers,
with the cost of doing an equal amount of business on a road of
four feet eight and a half inch gauge?

3. If you can do so, furnish the Committee with statistics re
relative cost of transportation on the roads of different gauges?
sons for thinking there is or is not a difference?

4. In your opinion would *small* cars, say of half the capacity c
narily used, be more economical than the latter, for a road wi
tively little traffic?

5. What do you think the difference in weight, *which is due t
between the rails*, would be between such cars of equal strength fo
gauge and for one of four feet eight and a half inches? And to
is the difference attributable?

6. What would be the difference in the percentage of cost of st

7. It is also said that narrow (three feet) gauge cars offer less
passing around curves than wide (four feet eight and a half in
cars of *the same character and weight*, in your opinion is there
difference in the power required to draw such cars around curve
feet radius, and are your conclusions based upon practical ex
theoretical consideration?

8. Do you think that for a section of country with a small tr
narrow gauge road would be more economical to operate than
light road and equipment of the standard four feet eight and a
gauge? And if either road would have any advantage over the
are they?

J. T. ROBINETTE,
A., M. & O. R. R., S. S. Division,
J. U. EASTMAN,
N. & C. R. R.
W. BELL SMITH,
S. C. R. R.

Please address replies to J. T. ROBINETTE, M. M. S. S. Divisi
O. R. R., Petersburg, Virginia.

Mr. FORNEY, Railroad Gazette—Mr. President, this is a subje
[illegible] generally discussed the country over for the last t

years, and I should have thought the Committee would have been able to gather some information of value concerning it. I see that the whole narrow-gauge controversy is based on the assumed fact that cars on narrow-gauge roads can be made much lighter than those on broad-gauge roads and yet carry about the same weight. If that be a fact I do not see why it has not been positively demonstrated instead of assumed. It is also claimed that there is less resistance in going round curves on narrow-gauge roads, but my impression is that the inferior stability of such roads more than offsets that advantage. I for one would like to know why cars on narrow-gauge roads can be built so much lighter than those on broad gauge. I have my doubts on that subject.

Mr. Ross, Memphis & Charleston Railroad—Mr. President, we are operating or trying to operate about twenty-five miles of narrow-gauge road. We find the light ties sink into the soft earth so much in our country as to make the track too uneven for use. We will have to put them closer together and make some other changes in the track. When that is done I may be able to give some results. I think the road will be a success.

Mr. Fry, Grand Trunk Railroad—Mr. President, this is a very important subject. It has been widely discussed by the public, and is liable to be put to us in a practical form at any time. I am glad we have one Master Mechanic who has had some experience with narrow-gauge roads, and sorry he has not given us more of the information he must have about them. The questions to be solved are whether lighter cars and lighter engines, which are possible on narrow-gauge roads, can do the work now required of roads of broader gauge. There are several narrow-gauge railroads in this country and Canada, and I should think some of the members would have some information about them.

Mr. Lilly, of Indianapolis—Mr. President, I understand that there are some gentlemen here who have prepared papers on this subject; one particularly by Mr. Forney of the Railroad Gazette. I would request that Mr. Forney's paper be read.

Mr. Forney, Railroad Gazette—The paper which I have prepared is not on the subject of narrow-gauge railroads.

Mr. Sprague, of Pittsburgh—Mr. President, the impression I get from the paper read is that we must do away with narrow-gauge roads altogether. The paper goes too far there, I think, for there *are* sections of the country in which there is no question it is cheaper to build narrow than broad-gauge roads, where roads are at all necessary. In such countries as Utah and Washington Territory, where the country is being opened up, I am convinced they would answer every purpose of broad gauge; but for heavy traffic I do not, of course, think they would do as well.

Mr. Forney, Railroad Gazette—Mr. President, will the gentleman who has just spoken inform me why a narrow-gauge road can be be built so much

cheaper than a broad gauge. It is assumed that the road can be built lighter, and the cars and engines also; but is it a fact? I think it is extremely doubtful whether any narrow-gauge road, varying much from the ordinary standards of strength, capacity, and durability, will make much of a showing in favor of narrow-gauge theories.

Mr. SPRAGUE, of Pittsburgh—Mr. President, I positively know that I can build a narrow-gauge engine much cheaper than a broad gauge. You can make the engines and cars much lighter and run with a lighter rail. Such a road is all-sufficient for some new parts of the country, and is, of course, much cheaper than a broad gauge, which requires everything to be heavier.

Mr. HUDSON, Rogers' Locomotive Works—Mr. President, I think there are some questions connected with this subject of narrow-gauge railroads that ought not to be lost sight of. We should all strive to see how light we can build cars for any gauge. Many of us who were railroading twenty and twenty-five years ago recollect distinctly what small locomotives we had—what light cars and lightly-constructed roads. They did the business required of them. Rolling stock and roads became heavier as the transportation of the country became heavier. I can remember when eight-ton engines were run and did all the business required of them. It seems to me that in new countries light engines and cars and light tracks might be used successfully and economically until the traffic of the road warranted the laying of heavier iron and the construction of larger engines and cars. The gauge ought to be what it is, however, the standard being probably somewhat wider than it now is on most roads.

Mr. COLEMAN SELLERS, of Philadelphia—I would like to ask whether the Committee on this subject has sent in any communication stating why they did not make a report?

THE SECRETARY—Mr. President, some four weeks ago I wrote to the Chairman of the Committee, advising him that our annual meeting would be held here on the 14th of May, and requesting him to have his report ready and forward to me. I have heard nothing from the member, and expected that he would have his report here.

Mr. J. T. ROBINETTE, Atlantic, Mississippi & Ohio Railroad—Mr. President, I will state to the Convention that the information your Committee received from members in answer to their circulars was not such as to base a report upon. That is the reason no report was prepared. For myself I consider that this question belongs to the Civil Engineer, not to the Master Mechanic, and I don't see what we have to do with it at all.

Mr. SETCHEL, Little Miami Railroad—Mr. President, as I have had no experience in the management of narrow-gauge railroads I can give no valuable information about them drawn from experience; but I think we should all study and have some ideas on all subjects connected with railroads, and

place to say what we think about it. I differ with my friend Robi-
ink it is right and proper for us to discuss any subject pertaining to
Besides this Association being composed of Master Mechanics, it is
sed of a number of Railroad Superintendents. I think at the least
ere are no less than ten or twelve Master Mechanics of our Asso-
) have been promoted to the responsible positions of Superin-
Railroads. It strikes me, therefore, that this is a question of con-
nportance to our Convention. Practical views and the knowledge
rated facts, in regard to the advantages of broad and narrow-
oads, would be very valuable to the directors of railroads employ-
ise the question of the adoption of any gauge should arise on new
it is a question with which we should all be familiar. As to the
self, so far as we have light upon it, I think the narrow gauge
probably will do very well in those parts of the country where
ht and cheapness of the road and running expenses the principal
attained. Still, I am in favor of a standard gauge; with that, as
is of the road becomes heavier, heavier rails and rolling stock
ded without great additional cost. Those roads which have
iarrow gauge will become broader, at least up to the present stand-
country through which they run develops. The demands of the
determine the gauge and the weight and capacity of rolling
ilroads, and we will have to succumb to these demands. The
heavy cars of to-day are run is because they are necessary to meet
f the country. The people do not want anything less than a four
nd a half inch gauge. It is the public that call in use the heavy
alace and sleeping cars, and just as the people demand these
tions they regulate the gauge of the railroad and increase the
olling stock, and this determines the capacity of the cars neces-
he business of transportation.

Grand Trunk Railroad—Mr. President, there have been a great
of railroad built since the agitation of this subject began, and,
special prejudice against the narrow-gauge road, it seems to me
lirectly interested in the construction of those roads would have
narrow gauge if they had been satisfied as to its advantages over
auge. I mean, of course, those roads that are not in connection
ink lines of the country and dependent on them for a large share
iness. The present standard gauge seems to meet the wants of
system of the country, and that being the case I do not see that
ge roads can ever have the advantage over broad gauge. I very
ion whether narrow-gauge roads can be built and operated much
ly than roads of the standard gauge.

INETTE, Atlantic, Mississippi & Ohio Railroad—Mr. President,
of the country when there are questions of route and gauge

to be determined, it is considered the duty of the Civil Engineer to decide them, the Master Mechanic puts on the rolling stock, motive power, and decides matters pertaining to the boilers and machinery of engines, the smoke box, etc., but has nothing to do with speculations as to the width of gauge to be adopted. As I have before said, I fail to see what this Convention has to do with the subject.

Mr. J. Y. SMITH, of Pittsburgh—Mr. President, I have had a good deal of experience with narrow-gauge roads, and I have been their advocates so long that I am sometimes called "Narrow Gauge" Smith. In my time I have built engines ranging in weight from eight to forty tons, and know locomotives weighing as low as four tons can be successfully operated. We have built in our works twenty-four inch-gauge engines, which averaged the labors of from thirty-five to forty tons each. Such narrow-gauge roads may be built for the development of wood and iron regions where broad-gauge roads would be too expensive altogether. On gauges of three feet we have run engines weighing from ten to fourteen tons, and saved in the operation the labor of forty mules. We have made such locomotives to run on twelve pound rails. I regard narrow-gauge roads as far cheaper and fully as useful as broad gauges in opening up lumber and iron regions, and for those sections where traffic is yet light. My experience with the narrow-gauge engines we have built is that in carrying loads there is about twenty-five per cent., or one-third more, in favor of the narrow or three-feet gauge than in the four feet eight and a half inch road. Still I do not claim that narrow gauges will do for all sections of the country. I am favorable to narrow-gauge roads because I have goods to sell.

Mr. FORNEY, Railroad Gazette—It strikes me that the same argument the gentlemen makes in favor of narrow gauge will hold good for the standard gauge in both cases. They both "have goods to sell."

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I would like to ask Mr. Smith whether the grades on which he demonstrated the twenty-five per cent. in favor of the hauling of the narrow-gauge engines were the same as those on which the four feet eight and a half inch engine was tried?

Mr. SMITH, of Pittsburgh—Yes sir; they were the same, and the result was as I have stated it. The philosophy of the advantage in favor of the three-feet gauge I have not yet discovered. There's a little difference in favor of the narrow guage on a short curve, but at a slow speed and on a straight track there's no difference between them whatever.

Mr. HUDSON, Rogers' Locomotive Works—It is evident, Mr. President, that narrow-gauge roads can not be run with light rails. The Festiniog, the parent of all narrow-gauge roads, was originally laid with rails weighing sixteen pounds to the yard. It has been relaid three times. The last rails put down weighed forty-eight pounds to the yard, and they are taking those

up and putting down heavier ones yet. The road is now operated with locomotives weighing as high as twenty-two tons. It is clear that narrow-gauge roads must undergo expansion as the business of the public demands it.

Mr. Forney, Railroad Gazette—I would like to ask Mr. Smith whether the difference in the hauling capacity of the two locomotives he has mentioned, as showing in favor of the narrow gauge, was a showing of gross weight hauled? Was there any difference in the weight of the cars with which the hauling was done?

Mr. Smith, of Pittsburgh—As near as I can remember the wide-guage cars weighed from five to seven tons; the narrow guage from four to five tons each. As to the engines, we hauled more tons on the narrow guage than on the broad by engines built from the same patterns.

Mr. Hudson, Rogers' Locomotive Works—I would like to ask Mr. Smith if he can give us the weight of each of those locomotives. As I understand him they were of about the same size, except as to the difference of gauge.

Mr. Smith, of Pittsburgh—I think the engine on the three-feet gauge weighed somewhere about fourteen tons; the wide guage from fourteen and a half to fifteen tons. The weight was in favor of the wide gauge.

Mr. Robinson, Great Western Railroad—Mr. President, I think we are getting some valuable information on this subject, and I hope the Committee having it in charge will feel encouraged to investigate it as fully as possible before our next meeting. If it can be demonstrated, as a member asserts here to-day, that a narrow-gauge road can do a third more work than a broad-gauge road, it is important that all railroad men should know the fact. However that may be, it seems clear to me that narrow-gauge roads may be made of great utility and profit in opening up agricultural districts where the means are lacking to build broad-gauge roads. We should have all the information accessible in regard to the cost of building and operating such roads. For roads of heavy traffic and long trunk lines, however, I am settled in the opinion that nothing less than four feet eight and a half inches will do. So far as the propriety of our discussing this subject and inquiring into it is concerned, I think we should *do both*. It is something which concerns us very much. Some time after that little railroad in Wales was started, the Master Mechanic of the road, or the person occupying a corresponding position, was waited on by a commission of royal appointment from Russia and from France. They asked all manner of questions in regard to the operation of the road, its rolling stock, etc.: they went to the Master Mechanic, not to the Superintendent and head officers of the road. We can not get too much information in regard to anything connected with the mechanical operation of railroads.

Mr. Wells, Jeffersonville, Madison and Indianapolis Railroad—I presume not very many of us will differ as to the advantages to be derived from the use of small engines and cars on those little roads where they can do the

work which horses have done heretofore. There can be scarcely any difference of opinion about that. The question is whether narrow-guage roads can be made to do the work of roads of standard gauge having great travel and heavy transportation. That is the question upon which we differ, and I suppose we would differ on some points connected with it if we discussed the matter all day. There is no doubt in my mind that the present standard guage is necessary for the traffic of roads having a heavy business, and I hardly think it will be reduced.

Mr. KEELER, Flint and Pere Marquette Railroad—Mr. President, I move the discussion of this subject now close.

Carried.

The Secretary read a letter from Colonel Gardner, of the Pennsylvania Railroad, inviting Western members, on their return home, to join in an excursion over that road from Harrisburg to Pittsburgh on Saturday.

On motion of Mr Wells, of the Jeffersonville, Madison & Indianapolis Railroad, the invitation was received and a vote of thanks extended to Colonel Gardner.

SECRETARY SETCHEL—Mr. President, Mr. R. V. Dollney, a former Master Mechanic, states to me that at our former meeting at Louisville he sent his assessment fee to Mr. Dodge, our Secretary at that time; I find there is no record on the books, and he desires to know whether the Convention will regard him as a member or not. He desires very much to participate in the proceedings, but is not certain whether he is entitled to or not.

Mr. SPRAGUE, of Pittsburgh—Is he a Master Mechanic at present?

SECRETARY SETCHEL—At the present time I believe he is not.

THE PRESIDENT—If there is no record of his admission to the Association, and he is not a Master Mechanic at present, I do not see that the gentleman is eligible.

On motion, the Convention adjourned to 8 o'clock P. M.

EVENING SESSION.

'he Convention met pursuant to adjournment at 8 o'clock P. M., President tton in the chair.

'he President announced that Mr. Brown of the Erie Railroad being unato serve on the Committee appointed to prepare subjects for discussion at next annual meeting, he would appoint Mr. C. R. Peddle of the St. is, Vandalia & Terre Haute Railroad in his stead.

HE PRESIDENT—The next business in order is the report of the Comtee on the Construction and Operation of Solid-end Connecting Rods for omotives.

port of the Committee on the Construction and Operation of Solid-End Connecting Rods for Locomotives.

he American Railway Master Mechanics' Association:

ENTLEMEN—Your Committee beg leave to report that in the charge of their duties they prepared a circular with the following uiries:

. Have you ever used parallel rods with solid ends?

. Were bearings made of brass or were the ends of the rods bored it pins?

. If gibs or boxes were used, did you use keys for adjusting m?

'ollowing these questions was an earnest request for the results of experience with the subject before your Committee. The duties your Committee, as understood, have been simply to solicit this rmation and lay it before the Association without intruding their opinions, leaving the discussion of the subject, farther than wn by the correspondence and any definite recommendations or gestions, to the Convention itself.

t is but justice to say that the individual experience of your nmittee with the solid-end rods has been so limited that, were y so disposed, they would not feel justified in deciding against ir use, supported as they are by some of the ablest members of Association.

To the inquiries of your Committee replies from the representatives of twenty-six different roads and manufacturing companies have been received, of a nature so diverse as to render the task of classifying somewhat difficult; but it is believed the following represents very nearly the preferences of those making reply:

Eleven have never used them, and are, of course, without well-grounded preference.

Three report having used them, but are not using them now, believing them more expensive and less serviceable generally.

Five have used both solid and those connected with strap, but express no preference.

Four are using both kinds, with preferences for the strap.

Three favor the solid end.

Showing but a small minority only who favor the continuance of the solid-end rod. Of these three, two—Mr. Fry of the Grand Trunk Railway of Canada, and Mr. Boone of the Pittsburgh, Fort Wayne & Chicago Railway—presented the Committee with drawings showing the method of using on their respective roads which are attached to this report.

The only recommendation your Committee would make is that the matter be fully discussed in Convention, when the merits of the different kinds could be more clearly presented than your Committee from the data furnished could present.

Respectfully submitted,

J. SEDGLEY,
L. S. & M. S. R. R.
J. W. NESBITT,
T. H. & C. R. R.
N. E. CHAPMAN,
C. & P. R. R.
Committee.

The following letters from Messrs. Howard Fry, of the Grand Trunk Railroad, and Jas. M. Boone, of the Pittsburgh, Fort Wayne and Chicago Railroad, each accompanied with a drawing of the style of connecting rod used on their roads, arrived too late to be included in the report of the Committee on Connecting Rods, but are considered of sufficient importance by the Printing Committee to be inserted in our Annual Report.

J. H. SETCHEL, *Secretary.*

MES SEDGLEY, Esq., *Chairman of Committee on Connecting Rods for Locomotives:*

DEAR SIR—In reply to your circular about solid and parallel rods, beg leave to state that all our standard engines on the Grand ank Railroad have coupling rods with solid ends. We find them ap to make and very simple to keep in order; avoid all danger m straps or bolts breaking, and the facility for taking down and tting up is obvious. In England solid-end coupling rods are the e; and during a service of eight years, on the South-eastern ilway in that country, I never heard of straps being used.

In England and here we use brasses for bearings very similar to at are used with straps. In order that you may see the arrangent I send you a rough tracing of the rod we use here, and also one used on the South-eastern Railroad in England. You will tice that the rod we use in Canada is plain and ugly in form, no ention having been paid to beauty of design, the desired end is attain in the cheapest manner possible. The oil cup must be de separately and screwed on. The English rod, on the other nd, is of very neat design, though very difficult to forge—the oil p being forged with the rod, and the bearings for the set screws also formed by enlarging the rod. In English practice one set ew is not considered safe.

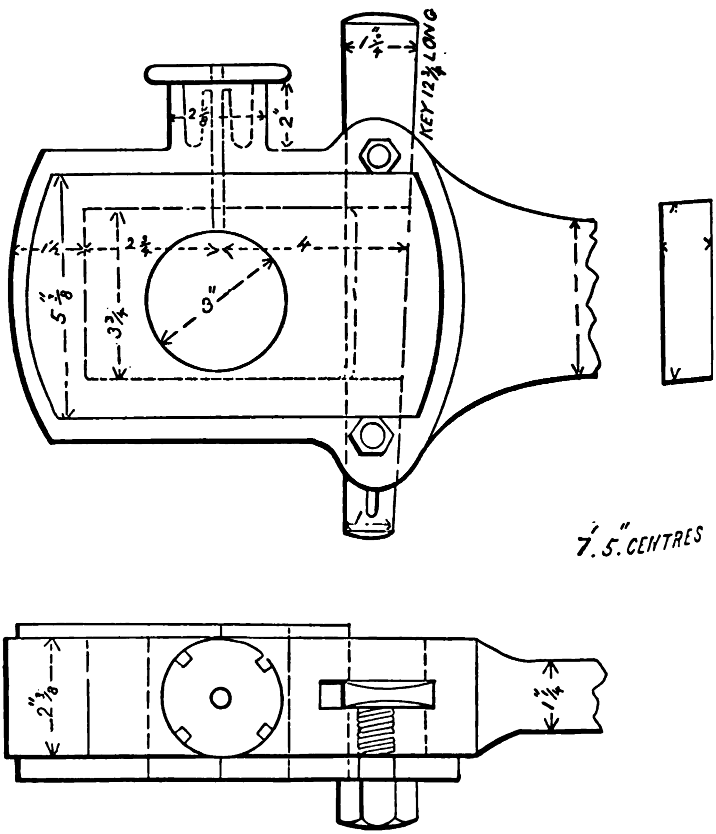
You will notice that the rod used in Canada is of unusual breadth npared with its thickness—this design was adopted by the late comotive Superintendent in Montreal, Richard Eaton, Esq., in er to prevent the breaking of the rods, which during the winter of frequent occurrence. Since the adoption of these slim, deep s I have not known one instance of side rods breaking, though getting through snow drifts the driving wheels have to be slipped an enormous extent. Our connecting rods in Canada are fitted h ordinary straps and bolts. In English practice it is quite comn to have solid-end connecting rods similarly arranged to the side ls I have mentioned, though, of course for outside cylinder enes only.

Yours truly, HOWARD FRY,

Assistant Locomotive Sup't Grand Trunk Railway.

Coupling Rod for S. E. R. Standard.

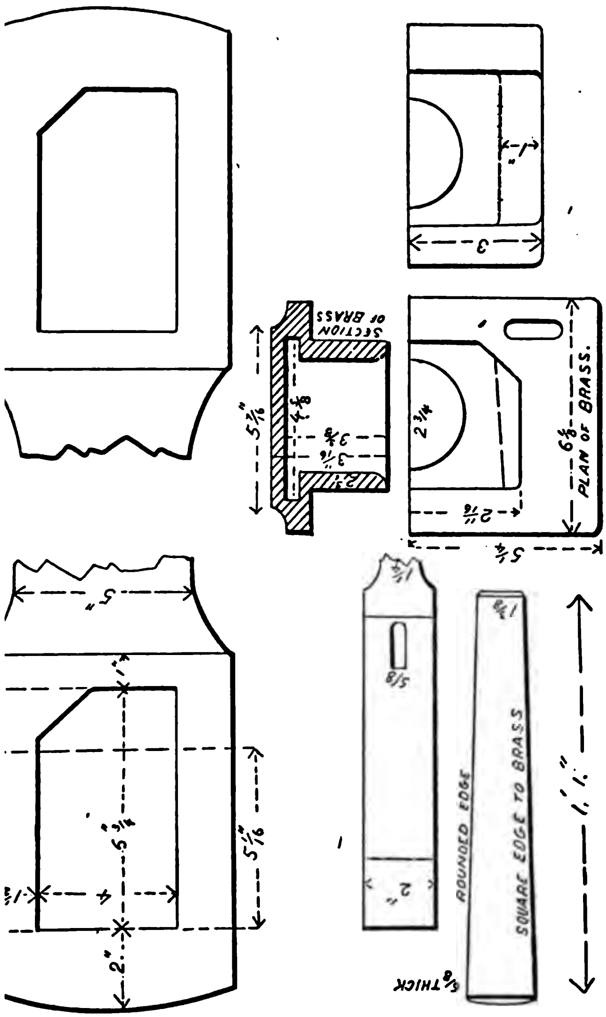
FOUR-WHEELED COUPLED ENGINE.



Cylinders 16" × 24".

Wheels 6'. 0' diameter.

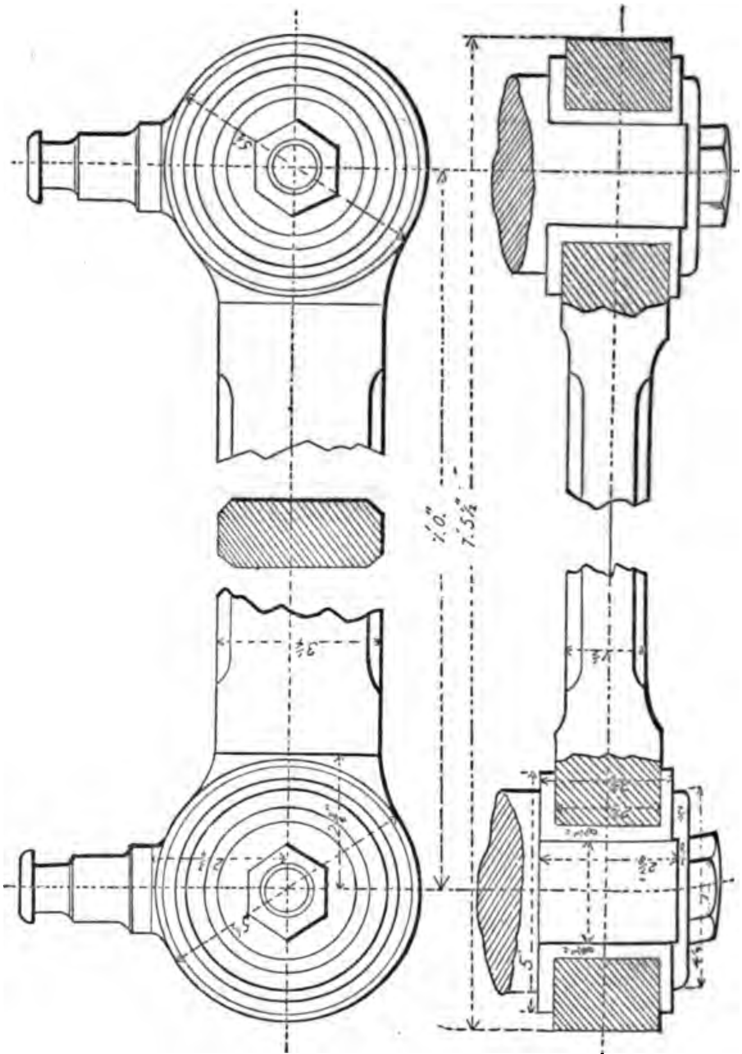
Grand Trunk R. R. Standard Coupling Rod.



HOWARD FRY, *Locomotive Superintendent.*

Parallel Rod for McQueen Engine.

PITTSBURGH, FORT WAYNE & CHICAGO RAILROAD.



JAMES M. BOONE, *Master Mechanic.*

FORT WAYNE, INDIANA, March 20, 1873.

[JAM]ES SEDGLEY, Esq., *Chairman Committee on Solid-end Connecting Rods:*

DEAR SIR—In answer to your circular I would say:

1. I am using solid-end parallel rods.

2. The bearings are made of brass, babbited; the ends of the [rod]s are bored out and brasses turned to fit them, and then forced [in] with hydrostatic press, the brass having been bored out to slip [on t]o pins; the brass being made in two halves, each with flange and [jo]ing in center of length of bearing.

3. There is no means of adjusting them, the intention being to [run] them as long as possible and then replace them with new brasses. Those I have running are giving good satisfaction. I find one of the solid-end rods to weigh thirty-two pounds less than one of [the] usual style of rods for same engine, and cost of fitting up at [leas]t fifty per cent. less.

Herewith please find tracing of the solid-end parallel rod we are [usin]g.

Truly yours, JAMES M. BOONE.

[M]r. KEELER, Flint and Pere Marquette Railroad—I move the report be [rece]ived and filed.

[Ca]rried.

The Resistance of Trains.

[Th]e Committee on the Resistance of Trains on Straight and Curved [Trac]ks, and on Wide and Narrow-gauge Roads, and with Four or Six-[whe]eled Trucks, and with Long and Short Wheel Base, are ready to report [and] will be the next business in order.

GREAT WESTERN RAILWAY MECHANICAL SUPT'S OFFICE,
HAMILTON, ONTARIO, April 23d, 1873.

[To th]e *Members of the American Railway Master Mechanics' Association:*

GENTLEMEN—As your Committee, appointed on the subject of "[t]he Resistance of Trains on Straight and Curved Tracks, and on [Wi]de and Narrow-gauge Roads, and of Four or Six-wheel Trucks, [and] with Long and Short Wheel Base," we beg to report that we [dre]w up a set of questions which it was calculated would be pro[duc]tive of such answers as would enable us to submit a comprehen-

sive report, but it is with regret we have to state that only nine answers have been received to the three hundred circulars sent out, and even these contain such scanty information as to be of little value for the purposes required. A tabular statement of the replies that have been forwarded is attached, from which, together with our own experience, we beg to submit the following general remarks:

Six-wheel trucks are found to produce greater resistance, and as a consequence absorb more hauling power than four-wheel trucks carrying the same weight of car.

Generally speaking six-wheel trucks do not appear to be used except for the purpose of carrying proportionately heavier cars, such as baggage, sleeping, and other similar coaches.

In the case of a broken rail or broken axle, six-wheel trucks, if properly constructed, possess advantages in point of safety over four-wheel trucks; but, with proper care of track and attention to axles, four-wheel trucks for ordinary traffic purposes may be regarded as giving the best general results.

A reasonably long wheel base seems to be generally recommended as productive of steadier motion, and a standard of six feet between centers of axles in four-wheel trucks for four feet eight and a half inch gauge seems to be the most acceptable for passenger train cars, while about five feet would be equally approved of for centers of axles in freight cars.

No information whatever has been forwarded to us regarding narrow-gauge rolling stock in connection with this question, but the foregoing remarks are equally applicable to all gauges; and we do not think that any of our members would doubt the fact that the narrower the gauge the less the train resistance on curved tracks.

So far as the information elicited enables us to judge it would appear that no reliable experiments have as yet been made with rolling stock in this country, to determine the exact dynamic force or resistance in pounds per ton hauled, at various speeds and with different classes of trucks.

It was the intention of your Committee at the outset to have prosecuted a series of experiments with this object in view, but not succeeding in obtaining a suitable instrument for the registration of experiments of this nature, we can not offer any practical informa-

RS TO QUESTIONS.

No, 3.	No. 4.	No. 5.	No. 6
n the experience ob- on your road, which ption of truck pro- the most resistance or n, and as a conse- absorbs the most g power—those with heels or those with six , both carrying the weight of car?	State your experience in regard to the effect of long and short wheel base. In answering this, supposing it granted that the long wheel base gives the steadier motion under high speeds, how far is this advantage neutralized by its greater friction in passing round sharp urves and switches? In conclusion of your answer to this question, give your opinion as to length of wheel base that would best meet all requirements and give least train resistance for both passenger and freight cars on four feet eight and one-half inches track and on three feet track.	What is the dynamic force or resistance in pounds per ton hauled of passenger trains on your road, running at a speed of thirty miles per hour, on a level track, with 4-wheel trucks?	Give the sa formation wi wheel trucks.
e with six wheels.	About width of track gauge..	Tried no experiments.	Not Ascert
" "	Pass'ger not given; freight, 58 in.	"	"
nuch difference....	Prefers long-wheel base; 6-wheel; 102-inch; 4-wheel; passenger, 81; freight, 56......................	"	"
e with six wheels.	....	"	"
....	....	"	"
e with six wheels.	Approves of 6-wheel trucks as enhancing safety of passengers, and 72 to 78-inch centers for 4-wheel trucks........................	"	"
....	....	"	"
e with six wheels.	About width of journal centers...	"	"
....	....	"	"
e with six wheels.	For 4 feet 8½ in. gauge of track, 72-inch for passenger trains and 60-inch for freight.................	"	"

W. A. ROB

on the subject beyond what is published of European experi-
ts, where train resistance is usually given at about eight pounds
on on a level, straight, good-conditioned track. This, however,
g the result of European rolling stock, where the truck system is
in general use, would not be sufficient for our system, while the
l allowance for extra friction in going round curves would be
with American rolling stock than with European, in conse-
ce of the greater freedom in action of the truck system for such
ose.

conclusion, we would strongly recommend a series of experi-
s being undertaken, at the expense of the Association, to accu-
y determine the train resistance in pounds per ton of different
s of American rolling stock of various gauges and at different
ls.

ologizing for so limited and imperfect a report, we are, gen-
n,

Yours respectfully,

W. A. ROBINSON, *G. W. R. R.*
WM. JACKSON, *R., W. & O. R. R.*
C. T. HAM, *Late N. Y. C. R. R.*
Committee.

e following letter of REUBEN WELLS, of the Jeffersonville, Madison & napolis Railroad, to the Chairman of Committee on the "Resist- of Trains," etc., was received too late to be incorporated in the report e Committee, and by request of the Chairman is inserted in our annual t.

J. H. SETCHEL, *Secretary.*

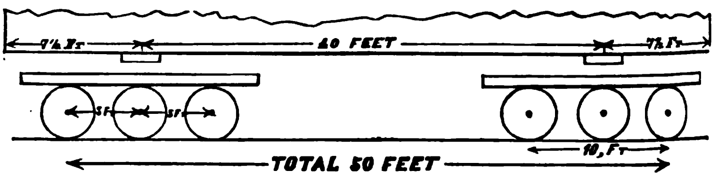
JEFFERSONVILLE, INDIANA, April 21, 1873.

A. ROBINSON, ESQ., *Chairman of Committee on "The Resistance of ains," etc.:*

EAR SIR—Your circular came to hand some time ago, but mislaid by some means, and I found it with the replies sent as Chairman of Committee on "Safety Chains," etc., and ply at this late day in consequence. I am sorry that the has been so long delayed, and am equally sorry that I can not

give you replies to the most important questions embraced in the subject.

1. Twenty with six-wheel trucks and thirty-two with four-wheel trucks; total wheel base of cars with six-wheel trucks as follows:



Cars with four-wheel trucks are of different lengths, from thirty-five to forty-five feet, and trucks also vary from a spread between wheel centers of six feet to seven feet in each truck.

2. We have about eight hundred freight cars; all have four-wheel trucks. Have had no experience with any other style of freight-car truck. The length of wheel base is twenty-four feet; the wheels in each truck are four feet ten inches between centers, the distance between the centers of trucks being nineteen feet two inches.

3. I have not *tested* the matter so as to determine positively, and can only give an opinion formed from general observation. Our road is comparatively straight, and such curves as are in it are of very long radius; and so far as my observation can determine the matter I am of the opinion that there is but very little difference in carrying a given load, whether on six-wheel trucks or four-wheel, *in hauling power*.

4. I consider that a wheel base (in one truck) of ten feet for six-wheel trucks under passenger, sleeping, baggage, and similar cars running in passenger trains, to be perhaps the best that could be adopted on roads with curves such as are found in the United States. I should not recommend a shorter wheel base than that. I have six-wheel trucks under some large baggage, mail, and express cars that have a wheel base in each truck of eleven feet, and have never found the least difficulty in running them on switches in the cities where curves are short, or on switches at any place; nor has there been any more wear on the flanges than on wheels in trucks of shorter base. I would consider five feet as a very good standard for the distance between centers of axles in trucks under freight cars, thus

›uting the weight on the track to better advantage, and increas- :eadiness in the riding of the car. I find that trucks of four en inches or five feet spread give better results than when the s are closer together.

nd 6. Can not tell; have never tested with either.

Have never made a test. Have had no instrument for making :est, but should like very much to be posted on that subject.

Respectfully yours,

R. WELLS, *M. M., J., M. & I. R. R.*

KEELER, Flint and Pere Marquette Railroad—Mr. President, I would ask the Committee if they know the amount of expense necessary to be ed in carrying on the experiments they recommend?

ROBINSON, Great Western Railroad—Mr. President, the principal ›f expense would be a dynamometer, such as is used in Europe. I ıever seen one of them in this country, and would like to ask whether ember here knows of one being in use.

SEDGLEY, Lake Shore & Michigan Southern Railroad—Mr. President, is an instrument of the kind in the hands of outside parties, I believe. ery simple in construction and would cost about one hundred dollars, I

LITTLE, of Philadelphia—Mr. President, I would like to obtain some ıation about this instrument. I understand the Pennsylvania Railroad ıny has been making some experiments on this subject. Perhaps Mr. es can tell us something about the instrument used.

DRIPPES, Pennsylvania Railroad—Mr. President—The dynamometer ›y the Pennsylvania Railroad was designed expressly to measure the n of the different classes of locomotive engines now in use in passing curves. It is self registering, both as to the power exerted in hauling and the distance-run, as it will register both ways, going either for- ›r backing. It will consequently register the force exerted in checking eed of trains. The machine is fastened on a car, and can be attached train. Its cost is about four or five hundred dollars.

LILLY, of Indianapolis—Mr. President, such an instrument has been n the Lehigh Valley Railroad, I understand. Perhaps Mr. Kinsey or ark can tell us something about its workings.

CLARK, Lehigh Valley Railroad—Mr. President, the only use we of the dynamometer we had was to contrast the strain upon engines in up some of the heavy grades on our road.

ROBINSON, Great Western Railroad—The cost of the article is what nt.

Mr. CLARK, Lehigh Valley Railroad—I suppose it would cost somewhere about one hundred and fifty dollars.

Mr. ROBINSON, Great Western Railroad—It may appear strange to the Convention that the Committee on this subject learned nothing about the use of the dynamometer in this country. As Chairman of the Committee I will state that there were three hundred circulars sent out on this subject, to which we received but nine answers, and none of them gave us any information about the dynamometer. It seems to me that if so many gentlemen here know about the instrument they might have answered the questions of the Committee. In regard to the dynamometer I will state that to be of any use it must be self registering. Such an instrument, I should think, might be purchased and owned by the Association, and any member who felt sufficient interest to make an experiment with it could do so. And this leads me to speak of what we shall come to presently, the subject of a mechanical laboratory for the Master Mechanics' Association. The time has come, I think, for the establishment of something of the kind to enable the members of the Association to make such practical experiments as they may deem necessary. I would move that a Committee on Mechanical Laboratory be appointed by the President, and that this question be referred to that Committee.

The motion was carried.

Mr. EDDY, Boston & Albany Railroad—Mr. President, there is one subject I have oftentimes thought it would be well for us to look into—one, I think, that has never been before the Association; and sometime before we adjourn I will make a motion to have a committee appointed to report on the action of oil used in our cylinders—to examine that subject and report upon it, and to see whether all roads suffer in the same way that we and other roads do.

THE PRESIDENT—Will you please state what you want to the Committee on Subjects for Discussion at the Next Annual Meeting of the Association, that they may include the subject in their list?

Mr. KEELER, Flint & Pere Marquette Railroad—Mr. President, I move that we proceed to the next report, and that the discussion on this subject be closed.

Carried.

THE PRESIDENT—The Committee on the Efficiency of Check or Safety Chains on Engine, Tender, and Car Trucks in Lessening the Danger Resulting from Running off the Track, are ready to report and will be the next business in order.

›port of Committee on the Efficiency of Check or Safety Chains on Engine, Tender, and Car Trucks in Lessening the Danger resulting from Running off the Track.

the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, to whom was referred the subject "The Efficiency of Check or Safety Chains on Engine, Tender, l Car Trucks in Lessening the Danger resulting from Running the Track," would respectfully report that they issued circulars which such questions were asked, as in our opinion were calcu- ed to elicit answers from the various Superintendents of Motive wer and Master Mechanics addressed, that would enable the Com- ttee to arrive at definite conclusions upon the subjects referred to, l enable them to recommend to the Association, for its considera- n and adoption, those plans and parts of this subject about which re might be but little diversity of opinion. The following is a ›y of the circular referred to:

SAFETY CHAINS.

'. ————, ————*Railroad:*

DEAR SIR—The Committee appointed by the American Railway ster Mechanics' Association on the subject of "The Efficiency Check or Safety Chains on Engine, Tender, and Car Trucks in ssening the Danger resulting from Running off the Track," would pectfully solicit your opinion on this subject, and we present ow some interrogations for your consideration. Yet we desire ı will not be confined entirely to them in your answers, but will e us such matters of information as will be calculated to bring ; the facts as to whether safety chains can be so applied that their ciency may, on the whole, warrant the expenditure in their ap- cation to all engine, tender, and car trucks, and their maintain- e in a condition to be entirely reliable under all ordinary circum- nces when subjected to such strains as may be brought upon m in case of accidents:

. Do you consider it practicable to apply safety chains and their fasten- s, of sufficient strength to all classes of trucks, so as to be entirely relia- under ordinary circumstances, and would their efficiency and certainty

in lessening danger in case of accidents warrant the cost of application and maintenance in good condition thereafter?

2. What should be the diameter of the iron composing the links of safety chains to engine trucks, and what for chains to tender and car trucks, and what should be the length of the links of chains to each class of trucks?

3. Should the point of attachment of the chain to the frame of engine, tender, or car, be as directly over where it is attached to the truck as practicable, with but sufficient length of chain to permit the ordinary movements of the truck while on the track, or should the chain be fastened diagonally from the points of attachment, and in the direction of the strain brought upon it, in preventing the truck from turning, or assuming a position to go off at a tangent from the direction of the rails, in case of running off the track?

4. Should all trucks have safety chains attached to each of the four corners, or do you deem two chains sufficient for each engine and tender truck?

5. Do you know of any instances where the use of safety chains prevented serious damage or destruction of life or property?

6. Is it your opinion that, as a means of safety, all center pins and king bolts of engine, tender, and car trucks should, in all cases, be securely keyed, so as to prevent the center pins from being drawn out of their places and to hold the trucks in their place, under all circumstances?

R. WELLS,
M. M. J. M. & I. R. R.
CHAS. R. PEDDLE,
Supt. M P. T. H. & I. R. R.
J. L. WHITE,
M. M. E. & C. R. R.
} *Committee.*

Please address replies to R. WELLS, J. M. & I. R. R., Jeffersonville, Ind.

Your Committee received answers to their circulars from twenty-four different Superintendents of Motive Power and Master Mechanics in the United States, Central America, and Canada. Of this number, nineteen were of the opinion that all locomotives, tender, and car trucks should have safety chains attached of sufficient strength to prevent the truck from assuming a position to run at an angle from the line of the track, in case of ordinary derailment, and to hold up the corner of the truck in case of the breaking of a wheel or axle, and prevent the truck in such case from being torn from its position by the corner falling upon the track and coming in contact with the ties, bridge timbers, or cattle guards on the line. One was of the opinion that safety chains should be applied to engines and tenders only, while three considered them unreliable,

)n that account did not attach them to the trucks under the ɪg stock in their charge.

those recommending the use of safety chains, ten give it as opinion that $\frac{7}{8}$ inch round iron should be used for the links in s to engine trucks, and twelve consider $\frac{3}{4}$ inch iron sufficient.

r chains to tender trucks, two advise the use of $\frac{7}{8}$ inch iron for fifteen $\frac{3}{4}$ inch iron, and four think $\frac{5}{8}$ inch iron sufficient.

: passenger and baggage car trucks, twelve are of the opinion ¦ inch iron should be used, and five recommend $\frac{5}{8}$ inch iron; and e chains to freight car trucks, nine are in favor of using $\frac{3}{4}$ inch and nine consider $\frac{5}{8}$ inch iron strong enough.

regard to the length of link for each size of chain, there to be but little diversity of opinion; with two or three excep- all recommend the standard adopted by chain makers known)le. The point of attachment of the chain to the frame of the e, tender, or car, is considered best when as near directly over oint where attached to the truck as practicable by nine, while ual number believe that the chains should be attached so as to diagonally, or nearly in the direct line of the strain in prevent- ɪe truck from turning, so as to run at an angle from the line ɪd in case of derailment. One recommends two chains for forward corner of engine trucks attached—the one immediately and the other diagonally from the point where attached to the . Another considers the point of attachment to the frame l be in a line directly forward of the point where the chain is ed to the trunk.

: opinion seems to be unanimous that where safety chains are :here should be four chains to each truck; three, however, con- that two is sufficient for each engine and tender truck, on ɪt of being usually run in but one direction. Eighteen reply hey know of a number of instances where the use of safety ɪ, in their opinion, was the means of preventing much destruc- f property, and perhaps in some instances the loss of life. It en also as the opinion of some that had safety chains been in instances that came under their observation, the destruction operty would have been very much less in those cases. In to keying the king bolts and center pins of all classes of

trucks, so as to hold them securely to the frame or body, there is but little difference of opinion expressed. Sixteen give it as their opinion that the trucks to engines and tenders should be thus secured, and fourteen express the opinion that the king bolts to car trucks should also be keyed. Four consider that trucks should not be keyed to the bodies of cars; that in case of a serious accident more harm than good results from holding the truck to the body.

Your Committee have carefully considered the answers given to the questions propounded in our circular upon this subject, and the reasons given for the conclusions arrived at by those answering, and, as there is on some points a wide difference of opinion, we have thought it best, in order to present the subject to the Convention for their consideration and action, to review the subject, taking each of the questions in the order in which they occur on the circular, and where a difference of opinion has been expressed we have taken the liberty to recommend what in our judgment seems to be the best, giving our reasons for so doing. Your Committee very much regret that so few of the Master Mechanics, out of the great number to whom circulars were sent, found it convenient or the subject of sufficient interest to them to reply, and that our report must on that account be based upon the opinion and views of so small a proportion of the whole number.

1. To the question as to whether it is practicable to apply safety chains and their fastenings so as to be reliable in cases of ordinary derailment, and in consequence lessening the danger in case of such accidents, there is scarcely any difference of opinion. All seem to agree that if chains are of sufficient strength and properly applied, the results in lessening danger and preventing in many cases great destruction of property, or perhaps life itself, would much more than pay for their application and maintenance. Those giving this as their opinion cite a number of instances coming under their observation which go to prove that in those instances at least it would seem the results were very satisfactory. Of the number of such cases we only cite one or two. The first is that related by Mr. Setchel, of the Little Miami Railroad. Sometime during the past winter both wheels were broken from the back axle in the forward

truck under the tender of one of their engines hauling an express train, that seven miles were run after such breakage before anything was known of the matter, the safety chains holding the truck up from the rails, the train running along at the usual rate, no other damage resulting. Another instance is related by L. H. Waugh, of the Kansas Pacific Railway, as coming directly under his own observation, where six cars in a freight train, running off the track at a defective joint, were hauled across a bridge one hundred and twenty feet long, the safety chains holding the trucks close to the rails, and the cars passing in that way entirely over the bridge, and receiving but little if any injury, and were afterward drawn on the rails and continued on in the train to their destination. One car in this train that was without safety chains received so much damage that considerable repairs were required before it could be put in service again. One of your Committee witnessed an instance where the forward axle in the truck of an engine broke while running at the rate of twenty miles per hour with a passenger train, the wheel running into the ditch, and the safety chains holding up that corner of the truck until the train was stopped, the other wheels in the truck remaining on the rails, no other damage resulted. A great number of instances can be mentioned where safety chains have proved efficient; and when of proper strength but few instances can be shown where they have not been efficient in ordinary cases. Chains will not in *all* cases, nor under *all circumstances*, prove efficient, in consequence of the extraordinary strains brought upon them in case of running over obstructions, or where the trucks are subject to unusual force from accidents other than those resulting from a broken wheel or axle, or simply derailment. There is no mechanical difficulties to overcome in order to secure sufficient strength of chain or fastening to ensure efficiency under ordinary circumstances. So far as the trucks under locomotives and tenders, passenger and baggage cars are concerned, there is scarcely any difference of opinion among Master Mechanics. All agree that each truck should have good chains securely fastened.

There is some difference of opinion, however, as to whether the benefits to be derived from the application of safety chains to freight cars would warrant the cost of application and maintenance. A

large majority favoring their application; the minority claiming that whenever such chains are called into requisition they have almost invariably failed and proved unreliable. The question would naturally arise, if safety chains can be made sufficiently reliable to warrant their application to locomotive, tender, and passenger car trucks, and that it is a wise precaution to use them, and if experience has shown in a number of cases that danger has been lessened and the destruction of property prevented by their use on the class of trucks referred to, can they not be made equally efficient, reliable, and valuable in their application to the trucks of freight cars? The statements made in regard to the failure of chains on freight car trucks are doubtless in many cases true, yet they can not be regarded as conclusive arguments against their use. It is well known to mechanics, who have given this subject attention, that safety chains, as they are applied to freight cars in a large majority of cases, especially on cars built by contract, are only safety chains in name, they are scarcely a good pretext—being either entirely too light, or the fastenings fearfully defective. A very common practice is to bend a piece of $\frac{5}{8}$ or $\frac{3}{4}$ inch round iron into the shape of a hook at one end, the other end being pointed and a thread cut on it; this end is screwed into the side sill or end sill of the car to the depth of about three inches, the hook having no other support than that derived from the part screwed into the sill. This furnishes the fastening for the chain, and the consequence is that when a strain of a few hundred pounds is brought upon the chain, if the latter does not easily break the "hook" does, or pulls out of the timber, sometimes splitting it in the operation. Other styles of fastening are in common use that are equally unmechanical and as unreliable.

In the opinion of your Committee, as well as that of a large majority of those giving an opinion on this subject, there seems to be no good reason why safety chains can not be made as effective and reliable attached to the trucks of freight cars as when attached to any other class of trucks. It will not be found difficult to devise fastenings for the chains that will be reliable under all ordinary circumstances, and that too without danger of splitting or doing other damage to the frame of the car. The cost of applying good chains and their fastenings to cars would average about $10 each. Esti-

mating the life of a car to be eight years' service, the account to safety chains would be as follows:

Cost of chains and fastenings	$10 00
Interest for eight years at eight per cent	6 40
Total	$16 40
Less value of old chains and fastenings	3 00
Total to be charged to account of safety chains for eight years	$13 40

This would be an average of $1.67½ per car per year. To equip five hundred cars with safety chains, at the above rates, would represent an annual expenditure of $837.50. Your Committee are of the opinion that safety chains can be attached to freight cars so as to be efficient under all ordinary circumstances, and be the means of lessening danger and preventing destruction of property; yet we are not prepared to give an opinion as to whether the advantages to be derived from the use of safety chains on five hundred cars would average each year $837.50 or not, as compared with the same number of cars having no safety chains, and we therefore submit this part of the subject to you for further consideration.

2. From the various opinions given as to the diameter of the iron composing the links of chains best suited for the different class of trucks, we recommend that for trucks under locomotives the chain links be made of a good quality of ⅞ inch round iron; for tenders, passenger, and baggage cars, and for all classes of freight cars ¾ inch iron be used. The fastenings of the chains should in all cases equal in strength that of the chain attached. The usual proof or test for chains made of ⅞ inch iron being fourteen tons, and for those of ¾ inch iron ten tons, which in our opinion gives sufficient strength of chain for the purpose designed. For length of links we would recommend that adopted by chain makers as a standard for the different sizes of iron used known as cable. A longer link for chains to freight car trucks, where considerable length of chain is required, would doubtless answer as well, besides costing less and having a less number of joints subject to wear.

3. There is much difference of opinion expressed as to the best point for attaching safety chains to the frame or body, relative to the point of attachment to the truck. One-half the number of

Master Mechanics giving an opinion on this subject are of the opinion that the point of attachment of the chain to the frame or body should be as near directly over the point where attached to the truck as practicable, while the other half give it as their opinion that the point of attachment should be such as to hold the chain diagonally, and as far as practical, at least nearly in the direct line of the strain brought upon it, in preventing the truck from turning so as to run off at an angle from the line of the track in case of derailment. Each plan has its advantages and disadvantages, and the difference in the conclusions arrived at doubtless arises from the different objects sought to be accomplished. If the object of a safety chain is simply to hold the truck from falling to the ground in case of a broken wheel or axle, or to hold the truck in place when off the rails and passing over openings, such as cattle guards or trestles, where under other circumstances the truck would fall from its place, and thus be a serious obstruction to the trucks and wheels immediately behind it, the plan of attaching the chain to the frame or body immediately over the point of attachment to the truck will best accomplish that object. For instance: if a wheel or axle under the forward truck of a locomotive having good safety chains attached to the corners of the truck and to the frame immediately over such point, no change of position would occur in the truck in consequence of the weight thrown upon the safety chain at that corner, and in all probability the other wheels of the truck would not—except occuring on the outside in a curve of the road—be thrown from the rails before the train could be stopped. But if the chain was attached diagonally, so as to be at an angle say of forty-five degrees to the direction of the weight to be supported, the strain upon the chain in consequence of the angle would be double that of the weight to be sustained, and the force tending to throw that end of the truck toward the opposite side would be equal to the weight sustained or downward strain, which, unless the flange of the opposite wheel was considerably worn, would be sufficient to cause the flange to climb the rail and throw that wheel off the track. But if the object is only to prevent the truck from assuming a position to go off at a tangent from the line of the track, in cases of ordinary derailment, it is evident that the nearer the chain can be

brought to the direction of the force to be overcome the better, and that object can be accomplished best by diagonal chains.

As the accidents against which the use of safety chains are intended as a means of lessening danger are of a variety of kinds, it would seem best that some plan of attachment should be adopted that will be a compromise—that will be best in the *majority* of cases when called into requisition. Your Committee are of the opinion that the point of attachment to the frame or body should not be far from that directly over where the chain is attached to the truck, the angle of a line from the point of attachment on the truck to that on the frame or body, and a perpendicular, being about twenty degrees, and in the direction that such angle will be increased most by the turning of the truck from the line of the rails, would, in our opinion, suit all cases better perhaps than any other, except chains to six-wheel trucks under passenger or other cars. These should be attached diagonally, as there is but little danger of a truck of that class dropping upon the rails in case of a broken wheel or axle. The point of attachment of chains to the frame of locomotives should be inside, or towards the center of the track from where attached to the truck, for the reason that in case of a broken wheel or axle the weight thrown upon the safety chains attached to the frame inside of the point where attached to the truck will tend to prevent the truck from turning toward the side having the breakage, and will, on that account, keep the opposite wheel on the rail. The angle of the chain should, however, not much exceed twenty degrees from the perpendicular.

We do not consider that any rule that could be given would apply to all cases equally well, and in the application of chains to the different styles and classes of trucks some variation from it will be found necessary to suit particular cases. No greater length of safety chain should be allowed than is requisite in passing the shortest curves upon which such cars or engines are run.

4. There should in all cases where safety chains are used, be one, attached to each corner of the truck. Upon this point there seems to be no difference of opinion.

5. With three exceptions, all who have replied to the fifth question report instances as coming under their observation where, in

their opinion, destruction of property was prevented by the use of safety chains. It can not be determined what damage would have resulted in these cases had there been no chains used, but judging from that resulting in cases where such chains were not used, their opinion is very decided in favor of their use. It is not stated by any that to their certain knowledge life has been saved in instances where chains were used, that would have been lost if safety chains had not been attached, yet the inference is that such has been the case in several instances reported. If, then, it is decidedly the opinion of the men who have had many years experience in the care and supervision of the rolling stock on the different railways of the country, that where safety chains have been applied they have in very many cases prevented destruction of property, it is equally conclusive that their application to all classes of rolling stock will in the same degree contribute to the saving of life, and where the question of human life is concerned the cost of application and maintenance can not be considered in the question at issue.

6. To the question, whether as a means of safety the center pins and king bolts to engine, tender, and all classes of car trucks, should be securely keyed, so as to prevent such pins and bolts being drawn out in case of derailment, or accidents from other causes, and thus securing the trucks in their position to the engine, tender, or car? their seems to be but little difference of opinion. All concur in the opinion that in engine and tender trucks the pins should be keyed, and with the exception of four, are in favor of keying the king bolts in all classes of car trucks, believing that in very many cases by having them thus secured to the body in case of accidents much less injury would occur on the whole. Of those dissenting from this opinion, one concludes that the safety chains are sufficient without the addition of keys in king bolts, and two give it as their opinion that in case of a severe accident the sooner the car bodies are clear of the trucks the less damage results in most cases. The opinion of the latter, that in case of serious accidents it would be best to have trucks freed from the body of the car, is doubtless correct in some cases, yet it is a fact well known to all who have closely observed the matter, that in very many instances much less damage occured from the fact that the trucks were held in place by

keys in the king bolts than if they had been left free and had drawn out. One of your Committee witnessed an instance where a night express train was thrown from the track by the washing away of a part of the embankment, and a passenger coach filled with passengers was prevented from being turned over into the water by the "ballast" given the body of the car by the trucks, the king bolts being drawn out as far as the keys in them would permit. The trucks resting at an angle, on the side of the embankment, were so firmly fixed in the soft earth that the body of the car was held with the sides at an angle of forty-five degrees from the perpendicular, and prevented from turning over into the water by the keys in the king bolts.

It would seem that if there are good reasons for securing the trucks of engines, tenders, and cars running in passenger trains by keys in the center pins, that cars running in freight trains ought not to be an exception in that particular. One advantage claimed in having the king bolts of cars free to draw out, is that in clearing a wreck no difficulty is experienced in separating the trucks from the car bodies and removing them separately if desired, whereas, if keyed, it would often be found difficult on that account to separate them, and equally difficult to remove them from the line without separating. This doubtless would sometimes be the case, yet many instances occur in which removal would be greatly facilitated if the trucks had remained in their place attached to the car body. It will be found that cars are much less likely to turn over in case of accident if the trucks are secured to the body so that they can not ordinarily be displaced, and in case the car does turn over the trucks go with it, and are not so likely to be damaged as if left on the road, and in many instances the cars can be turned back and put on the track with but little trouble and slight damage.

A great many instances occur when cars are thrown from the track that they require to be jacked up, and the trucks turned somewhat, or require to have blocking put under the wheels before they can be pulled out of the positions in which they are found and put on the track. In all such cases the matter is greatly facilitated if the trucks are keyed to the body and can be jacked up with it. Many other reasons could be given in favor of having trucks secured to

the body of the car, but your Committee deem it unnecessary. The expense of putting keys in center pins and king bolts is so trifling as to be scarcely worth mentioning. In accordance with the almost unanimous opinion of all who have expressed themselves to us on this subject, and our own observation, we believe that on the whole much less damage would result in case of accidents if center pins and king bolts of all classes of trucks were keyed, and we recommend it as a means of safety.

Respectfully submitted,

R. WELLS,
M. M. J., M. & I. R. R.
C. R. PEDDLE,
St. L., V., T. H. & I. R. R.
J. L. WHITE,
E. & C. R. R.
} *Committee.*

On motion the report was received.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—Mr. President, there is one point in connection with this subject which the Committee seems to have neglected, and on which they make no recommendation. That is, whether the cost of chains on freight cars is counterbalanced by the advantages of safety, etc., derived from their use. The cost of a set of chains would probably be ten dollars a car, or a dollar and sixty-five cents a year, taking the average lifetime of a car. Now for five hundred cars that would be about eight hundred dollars, and I would like to hear from the Convention as to whether the advantages to be derived from the use of chains on freight cars would amount to that much over and above those of cars having no chains.

Mr. KEELER, Flint & Pere Marquette Railroad—Mr. President, the Committee do not tell us as much about the advantages of different fastening points as I wish they did. In reference to this question we must take into consideration that we have two kinds of accidents to contend against. One is accidents from defective wheels and axles; the other, our liability to be thrown off the track. Most of our breaks occur at the axle. One trouble is that car inspectors are not careful enough to throw suspicious axles out. A good car inspector who understands his business will throw all axles out that look anyway defective, and if that work is done well there is comparatively little danger from axles. Our greatest liability seems to be from being thrown off the track, and in that case the fastening should be at the point of the greatest strain.

Mr. WHITE, Evansville & Crawfordsville Railroad—Mr. President, In

er to the gentleman who has just taken his seat I would like to ask the ention in case, for instance, the right-hand wheel should break, the s being suspended at an angle of some forty-five degrees from perpendicu- whether the weight thrown upon the truck at that instant would not have dency to draw the forward end of the truck around and press the upon the rail, preventing the unbroken wheel from remaining on the ?

. FRY, Grand Trunk Railroad—Mr. President, the chains, if properly ed, I should think, would keep the truck in place. One of the great of accidents is broken rails. If a road has the broken rails properly d after there will not be so many broken wheels and axles. I think f that the roads of this country are so rapidly improving that we may orward to the time when accidents from defective rails will be fewer those from defective axles and wheels. It is easier to keep a road in than it is to guard against defective axles and wheels. Sometimes it is sible to detect defective wheels, and that, I think, will be found to be rincipal difficulty.

. KEELER, Flint & Pere Marquette Railroad—Mr. President, the gen- n's experience is altogether different from mine. Nearly all our nts occur from being thrown off the track. I don't think we have a broken wheel or axle from under our cars since I have been on the

. GORMAN, Toledo, Wabash & Western Railroad—Mr. President, we experieced run-offs from a good many different causes. Many times n't tell exactly what the cause is. The question seems to be now is the most safe and proper method of keeping the trucks from slooing d when they do go off. I agree with the Committee exactly, that the chains are too light, altogether too light. When you go off the track ne wheel you want to have the truck kept in position and as near the as possible. If your chains are not strong enough to keep the truck in around goes the truck. The remedy for this is the employment of heavy, substantial safety chains, and I would have them placed on car and engine on the road.

SPRAGUE, of Pittsburgh—Mr. President, I would like to ask whether f the members present know of check chains tearing out sills? I have n advocate of safety chains for years, but a number of persons have e that they will pull sills all to pieces. I would like to know whether s the fact.

GORMAN, Toledo, Wabash & Western Railroad—Mr. President, I will at I never knew an occurrence of that kind. I do not think it is a fre- occurrence, at least, when the chains are properly fastened. Even if ere the case it would be better to tear the sill of the car out than to do

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—Mr. President, I will state for Mr. Sprague's information that I have seen cases where the sill was split, but it was on account of improper fastening. If the fastenings had been properly made all the strain would not have come upon the sills as it did, and no injury would have resulted.

Mr. LILLY, of Indianapolis—Mr. President, the report of the Committee is very elaborate, and as it has nearly exhausted the subject I would move that the discussion be closed.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—Before we pass from this subject, Mr. President, there is one point in the report upon which I hope the Convention will take some action. The Committee has made no recommendation in regard to the application of safety chains to freight cars, as they could not agree as to whether the advantage to be derived from them would warrant their use.

The President ruled Mr. Lilly's motion out of order.

Mr. GORMAN, Toledo, Wabash & Western Railroad—Mr. President, in regard to Mr. Wells' remarks I would say that, in my judgment, safety chains should be applied to all trucks, to all trains, whether passenger or freight. We all know that they are a great protection to trains, and they consequently must be a saving. Nine times out of ten, when one truck gets out of place and has no chains to hold it to the track, it throws its own car and five or six others off the track. I would like to see it adopted as the sense of this Association that all trucks under all engines, tenders, and cars should be provided with safety chains.

Mr. PHILBRICK, Maine Central Railroad—Would it be proper to recommend by the same vote that these chains be three-quarter inch iron as recommended by the Committee?

Mr. GORMAN, Toledo, Wabash & Western Railroad—They should be at least three-quarter inch iron, and more if necessary.

Mr. PHILBRICK, Maine Central Railroad—Mr. President, here is a stick five by twelve; to attach to that a chain of three-quarter inch round iron, it strikes me, would be a strain very much larger than that stick can hold. I never saw a fastening put where this stick goes that would hold one-half of it.

Mr. GORMAN, Toledo, Wabash & Western Railroad—Mr. President, I think the wood will hold it; and unless you have the chains strong enough to stand the strain of a sudden jerk, such as they are often subjected to, it is no use having them at all.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—There are hr ee pieces between the center of the car and the sides to stand the strain, and it appears to me they will hold chains of the size proposed.

The question coming to a vote, Mr. Gorman's motion to recommend

e application of safety chains to all engines, tenders, and cars, was opted.

On motion of Mr. Chapman, of the Cleveland & Pittsburgh Railroad, the scussion was closed.

The next business in order being the report of the Committee on Mainery for Removing Snow from the Track, Mr. Philbrick moved that as Committee had not the drawings necessary to illustrate some parts of the port the subject be postponed until the next morning, which was carried.

Mr. Robinson, Great Western Railroad—Mr. President, I move that a nmittee of three be appointed to select a place for holding the next Conntion of this Association, to report to-morrow morning.

The motion was carried, and the President appointed as such Committee ssrs. Healey of the Providence Locomotive Works, Kinsey of the Leh Valley Railroad, and W. Bell Smith of the South Carolina Railroad.

The President also appointed as the Committee on Mechanical Laboratory, ssrs. Robinson of the Great Western Railroad, Wells of the Jeffersonle, Madison & Indianapolis Railroad, and Boone of the Pittsburgh, Fort ayne & Chicago Railroad.

The report of the Committee on Machinery for Supplying Fuel and Water Locomotives being the next business in order, Mr. Garfield of the Hartd, Providence & Fishkill Railroad, said the Committee had no report to esent, as the Chairman of the Committee, Mr. Leech, had the answers to e circulars sent out, and had not yet arrived.

The report was postponed.

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—There was communication from Colonel Gardner of the Pennsylvania Railroad, which obably ought to be answered.

Mr. Keeler, Flint & Pere Marquette Railroad—I move that a committee appointed to confer with the members in regard to the matter, and report -morrow morning.

Carried.

The President appointed as the committee, Messrs. Keeler of the Flint & ere Marquette Railroad, Young of the Cleveland, Cincinnati & Indianpolis ailroad, and White of the Evansville and Crawfordsville Railroad.

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—As there as been considerable discussion in regard to some matters which have come efore the Convention which, in the opinion of many of the members should ot have taken place, I beg leave to offer the following, to be added to rticle V as an additional section. The last section of that Article is 4 his will be Section 5 and read as follows:

"During the business sessions no communications shall be re-

ceived or acted upon other than those pertaining to the business of the Association."

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—I presume the gentleman means this as an amendment to the Constitution.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—The Constitution is the only by-laws we have, I believe.

The section was adopted.

The Committee on Printing presented the following report:

Report of the Committee on Printing.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, appointed at the last Annual Session upon Printing, beg leave to report that they have, in attending to the duty assigned them, notified several different parties and received propositions from three of the principal and most reliable printing houses of Cincinnati, of which they accepted the one which to them seemed best and cheapest. The circulars of the various committees were printed by the same house as the Annual Report, at the regular figures charged for such work. The Secretary has now on hand a large supply of stationery, and but little more will be required the coming year. In this connection your Committee deem it proper to state that the Association have now on hand about two hundred and fifty copies each of the Third, Fourth, and Fifth Annual Reports, and as a large number of the members have expressed a desire to have copies of those numbers that are now out of print, your Committee would respectfully suggest that a sufficient number of the First and Second Annual Reports be printed in order to furnish members copies for binding and distribution.

Respectfully submitted,

H. M. BRITTON, *W. W. V. R. R.*
N. E. CHAPMAN, *C. & P. R. R.*
J. H. SETCHEL, *L. M. R. R.*
} *Committee.*

On motion, the report was received and the recommendation adopted.

THE PRESIDENT—There is one subject that should be taken up before we forget it, and that is the appointment of trustees for the control of the fund presented to the Association at Boston last year. Something has also been said about associate members. A number of applications have been made

or will be made. The Constitution provides for twenty associate members, and there are already about fourteen, I think.

Mr. SMITH, of Pittsburgh—While on these miscellaneous topics, Mr. President, I would suggest that the advertisements of men's business in some of the committees reports, such as I have heard to-day, might be omitted advantageously. I mean, particularly, the report of the Committee on Compression Brakes, which gives the price per car and some other advertising points. I think that sort of thing ought to be omitted.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I think if the gentleman will read the report in question he will not find anything objectionable in it. The Committee was instructed to make certain comparisons, and they could not do so without giving figures. I don't see that that is advertising anybody's business.

THE PRESIDENT—The Committee was instructed last year to report on the Construction, Operation, and Cost of Maintaining Continuous Train Brakes. I do not see how they could do that without presenting statements of the cost of operating the brakes and the cost of the brakes themselves.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—That was my understanding of the matter.

The report on Anti-friction Valves being called for, was read by the Secretary:

Report on Anti-Friction Valves.

RICHMOND STATION, April, 1873.

To the American Railway Master Mechanics' Association:

GENTLEMEN—In reply to our circular we have had answers from twenty-five Master Mechanics; of these nine speak unfavorably, and seven speak more or less favorably of the valves tried. The following are the names of those who speak unfavorably:

James M. Boone, of the Pittsburgh, Fort Wayne & Chicago Railroad, reports trying a set of roller valves for six months and finding them of no advantage whatever; name or description of valves not given. Also reports trying a balanced valve on two fast passenger engines, which at first seemed to promise good results but in practice found that it could not run two thousand miles without valve leaking, consequently abandoned it. Name of valve not given, but from description should think it was an Adams' valve, or one on a similar plan.

James Lamb, of the Des Moines Valley Railroad, reports trying

a set of Sault's roller valves, but without getting satisfactory re
Particulars of failure not given.

T. W. Peeples, of the Central Railroad of New Jersey, re
having had four sets of Bristol's roller valves in use on pass
engines for five years. They run from 40,000 to 60,000 miles
out facing, while ordinary valves on the same service only
30,000 miles. Repairs to link motion are less, but the repai
the roller valves makes up the difference. Finds no differen
consumption of fuel with roller valves, and does not thin
benefits derived from them warrant the expense of putting th

S. M. Cummings, of the Pittsburgh, Fort Wayne & Chicago
road, reports trying Sault's roller valves, but found the steel
that the rollers work on would come loose, weak, and the valv
not reliable. Tried the Thompson balanced valve, but found t
required more repairs than a common valve; also tried the H
balanced; the defect in this valve was that a valve seat had
bolted on the cylinder, and the bolts would get loose.

G. Richards, of the Boston & Providence Railroad, reports t
the Griggs valves, but they did not pay. Description of val
particular defects not given.

The following are the reports of those Master Mechanics wh
tried balanced valves with favorable results:

J. W. Philbrick, of the Maine Central Railroad, has ni
engines, all built by the Portland Company and fitted wit
valves designed by the Superintendent of the Portland C
Of these engines No. 1 has run 18,417 miles; No. 5, 51,
6, 17,000; No. 10, 34,351; No. 15, 38,668; No. 53, 19,
54, 17,316, and the valves in these engines have not yet
facing. Engines Nos. 19 and 20 have run, respectively,
75,000 miles, the valves having been faced once during
None of these valves have given any trouble except that the
casionally sticks in the grooves, but when it does so it is a
job to take it out and clean it. Mr. Philbrick also repor
a valve himself, which obviated this difficulty of pack
He has put it in two engines, one of which has run seve
and made 43,793 miles without facing, and the other
teen months and made 35,832 miles without facing.

be found of both the Morse and Philbrick valves attached to this report. The wear of valve seats and valve gear is less with these valves than with the old kind.

H. A. Alden, of the Connecticut & Passumpsic River Railroad, reports that he is using the Nesbitt and the Hutchinson valve. The Nesbitt valve, when not blowing through, works very well, is perfectly balanced, and the wear of valves and valve gear is imperceptible; but thus far it has been difficult to keep it steam tight, the steam blowing past the packing—though Mr. Alden thinks the defect can be remedied, and then the valve would be perfect. The Hutchinson valve is giving very good results—on the whole more satisfactory than the Nesbitt valve, though not yet perfect. No figures are given as to the mileage run by these valves.

J. A. Lauder reports having sixteen engines fitted with Nesbitt's valves. He describes the valves as having a circular top bored out to receive it; there are packing rings fitted in the valve and set out by small spiral springs against the cap to prevent steam getting over the valve. Mr. Lauder reports having used the valve over four years, and expresses the highest opinion of it. One set was put in a freight engine in February, 1869, and has run 100,000 miles; neither the valve nor seat has been faced during that time, and they are still tight. The repairs on the link motion and valve gear are very much less with this valve than with the common kind. No figures are given as to the consumption of fuel, but Mr. Lauder thinks that if there is any difference it is in favor of the balance valve. He has never found any special difficulty with these valves in fast trains, and considers them more trustworthy than common ones. They can be put into any ordinary outside engine for about one hundred dollars a set, the only alterations needed being in the coupling of stem to valve.

A. J. Stevens, of the Central Pacific Railroad, considers the benefits derived from using balanced valves so decided that no locomotive ought now to be built without them. He has used the Stevens valves for the last ten years, and has had no failure from them. He has now twenty-two engines with balanced valves, most of which have run three or four years, and of these only one engine has required the valves to be faced, and this engine had run 78,630 miles

at that time; this engine has since run 55,000 miles without facing and the other engines have run from 50,000 to 75,000 miles without facing and are still good. He is having seven more engines built with similar valves. Mr. Stevens' report is very full and interesting, and he sends a statement of the exact mileage of the engines with these valves—also the size of the engines, and a copy of a testimonial from the engine drivers stating that they prefer the valve to anything they have used before. These papers are attached to this report, as also is the statement of the Superintending Engineer of the Central Pacific Railroad Company's steamers that, in a steamer with a very large valve which continually broke the stems, he tried the Stevens valve, and since using it no stems have been broken.

W. H. Griggs, of the New York & Oswego Midland Railroad, reports trying four kinds of balanced valves. The Sault's roller, which was a failure from causes similar to those described by other Master Mechanics; the Robinson, which Mr. Griggs put into one engine on the Rome, Watertown & Ogdensburg Railroad, and which ran well for two years. Mr. Griggs then left the road, and therefore can not give any more exact data. The valve that Mr. Griggs has most confidence in is the Adams; he has twelve engines fitted with it. One engine ran for three years and two months without needing to be faced, and the average mileage without valve facing, with balanced valves, is from 60,000 to 75,000 miles; the repairs to valve gearing are also very slight. Mr. Griggs describes these valves as being very simple, and the working of them as perfect. The drivers like them, as they can reverse the engine so easily; and in snow drifts the labor of handling the engines is reduced to a minimum. The cost of putting in a set of Adams valves is $95.00. Mr. Griggs is also trying a set of the Nesbitt valves.

Mr. Fry, of the Grand Trunk Railroad, reports that on one division of the road under his charge he has eleven engines fitted with balanced valves, all of which have given the most perfect satisfaction, so much so that he has recommended them to be fitted on engines for other parts of the line, and now there are forty-two engines on the line with balanced valves. The first kind used was Adams' patent. Six engines, built by the Portland Company, were

fitted with them and gave most perfect satisfaction. The next tried was the Morse valve; these have also given entire satisfaction, but the engines have not been running long enough to decide whether the Adams or Morse valves are the best. The first Adams valves were put in two engines built in October, 1869. One of these engines had valves looked at for the first time in October, 1871, and one valve slightly faced—motion not touched. The other engine was not touched till October, 1872, when it had run 86,144 miles; valves were then only slightly worn and motion was as good as ever. Another engine, which had Adams valves in December, 1869, ran till December, 1872, before the chest covers were taken off, the engine having run 102,588 miles during the three years. The valves and faces were only slightly worn, and the motion as good as ever. Two other engines with Adams valves ran, respectively, 65,668 miles and 76,505 miles, before the valves were faced, and in each instance the work required to face them was very light, and in no instance has the valve gear required any fitting; pins, links, blocks, etc., being as good as ever.

The Morse valves have not been running long enough to require facing. The largest mileage run is 29,388 miles, but there is every indication of at least 70,000 miles being run before facing will be needed. The working of them thus far is perfect. There are no means of ascertaining whether there is any saving in fuel made in using balanced valves, but apparently there is no appreciable difference. The saving in wear and tear of valve motion is very great. Engines with balanced valves can be kept out of the repair shops much longer than engines with common ones; they are not liable to any sudden derangement, either on fast passenger trains or on freight trains, and the comfort of the drivers is greatly enhanced by having an engine that can be notched up or reversed as easily with throttle open as shut. We have also attached to this report a sketch of a circular slide valve that has been sent us from the patentee, Mr. J. S. Tallant of Burlington, Iowa. He claims to have put these valves into numbers of stationery and river engines, and that they have run well for five years. Says he has no influence among railways and has not had them tried on locomotives, but thinks they would do well. He refers to S. E. Burtch, the Master Mechanic of the Chi-

cago, Burlington & Quincy Railroad, as having seen the working of the valve; perhaps some of the members of the Association know Mr. Burtch, and could learn from him if the valve is worth testing. The cost of applying it to a locomotive would be $30.00.

In summing up these reports we may say, that though our circulars have been very imperfectly answered, and though there is, doubtless, a great deal of valuable experience on this subject which would be interesting to get, still we have enough facts to show that the mechanical difficulties of producing a practical balanced slide valve, trustworthy under every kind of locomotive work, have been overcome, and that two or three designs of valves are now in use that meet all the demands of locomotive practice. These valves are growing in favor with the Master Mechanics, and we hope soon to see a very extended introduction of them, especially into large engines, as it is with large valves that the destructive effects of excessive valve friction are most injuriously felt. We may also add that none of the Master Mechanics using roller valves have been favorably impressed with their working.

It will be seen that a good balanced valve, such as the Adams, the Morse, the Stevens, or the Nesbitt valve, will run from 75,000 to 100,000 miles without facing, while 30,000 miles is a good run for a common valve, and the repairs to the link motion are proportionately reduced. Nine Master Mechanics who have answered our circular have had no experience with balance valves.

HOWARD FRY, *G. T. R. R.*
A. B. UNDERHILL, *B. & A. R. R.*
JOHN THOMPSON, *Eastern R. R. of Mass.*
} *Committee.*

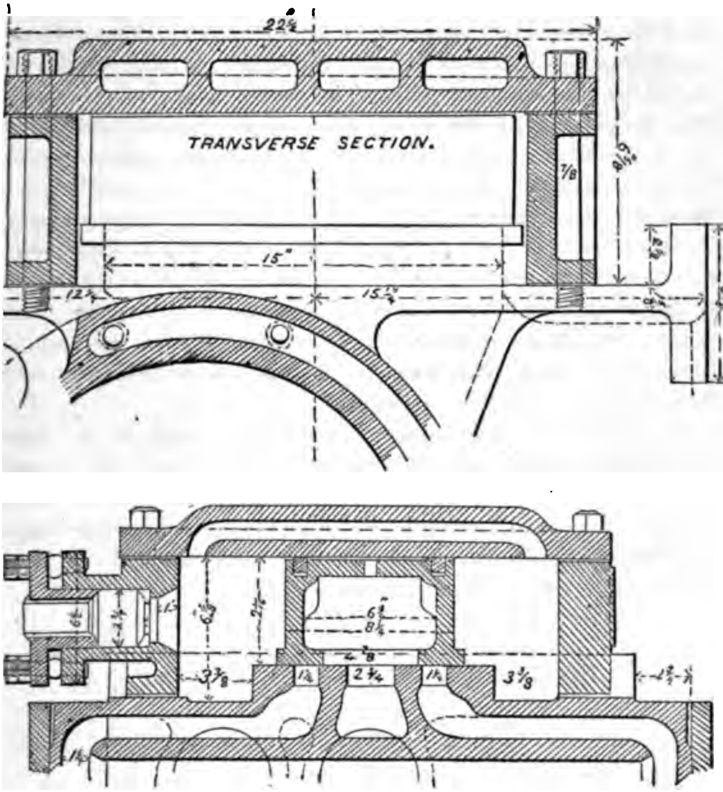
SACRAMENTO, CAL., January 29, 1873.

HOWARD FRY, ESQ., *Asst. Loco. Supt. G. T. R. R.:*

DEAR SIR—Your circular in relation to "balance slide valves" is at hand, and in reply would say the only balance valve with which I have had experience is one of my own invention (I inclose you photograph.) I have had this valve in use on both freight and passenger locomotives and steamboat engines during the past ten years, and in no instance have they failed to give entire satisfaction. I think a slide valve that is exposed to the full pressure due to the size of the

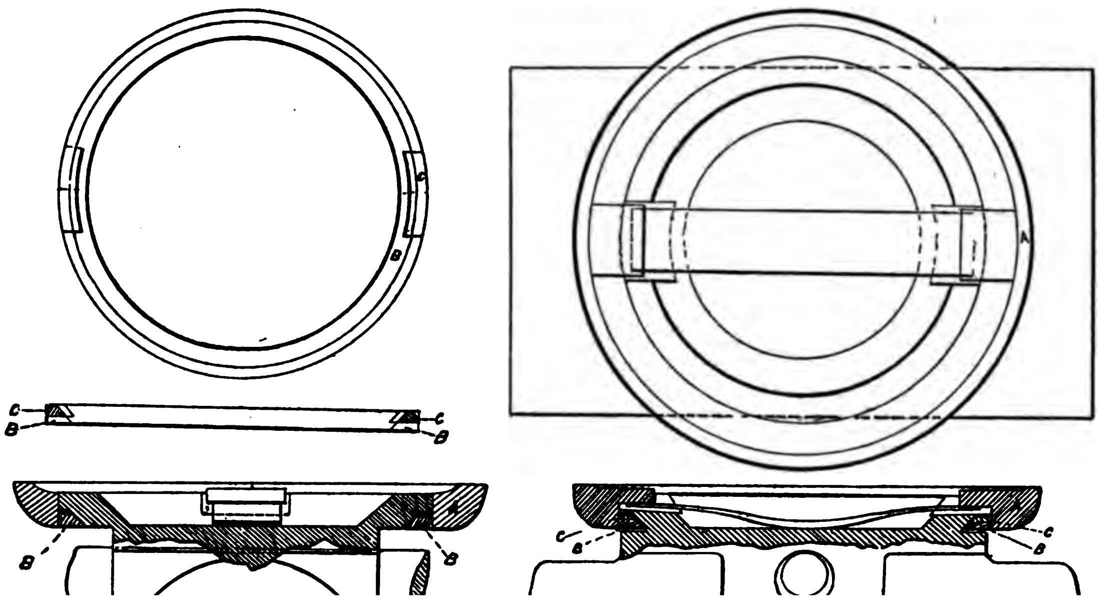
Balanced Valve for Locomotives.

(MORSE'S PATENT.)



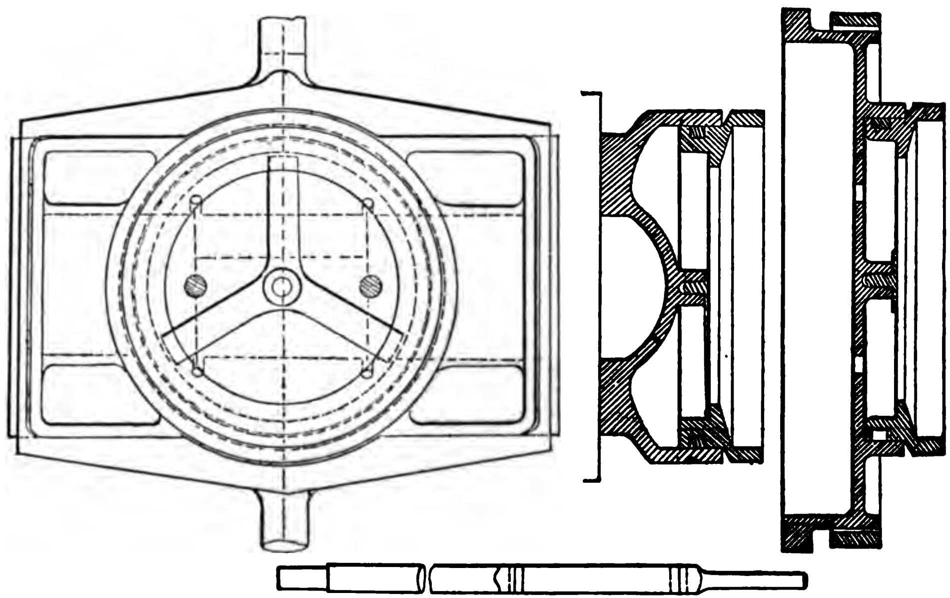
Half Size.

Maine Central Railroad Balance Valve.



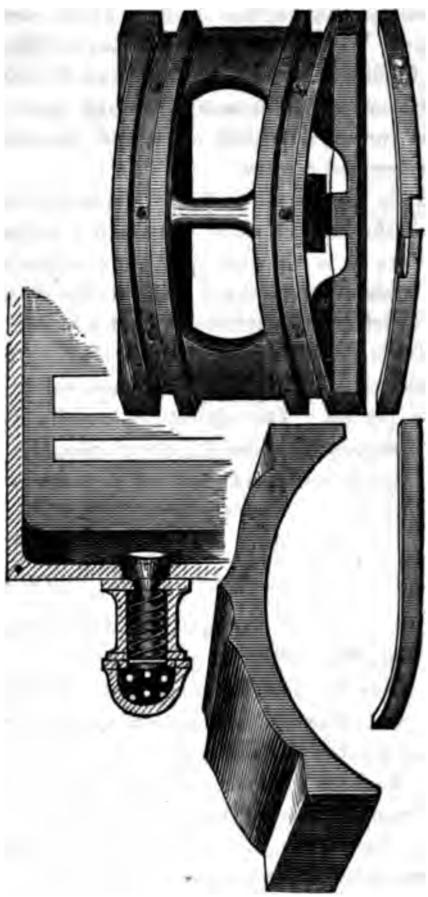
Balanced Valve and Stem for Locomotives.

(ADAMS' PATENT.)



NOTE.—The displacement ring D to be fitted a bare 1-32 in. slack in V. The packing ring R to have 3-16 in. cut out of it before being turned and the joint held

The Nesbitt Balance Valve.



openings under it, as is the case with the common valve, should not be used on a locomotive engine. My experience with the balance valve has been so favorable I could not be induced to use the common valve, and I am putting in the balance valve as fast as possible. On an average, with the common valve, we find it necessary to face the seats on coal-burning engines once in about every 18,000 miles the engine runs. We have a large number of balance valves that have run over 50,000 miles; several have run 60,000 miles, and the seat and gearing are good for many thousand more. We have one engine that has run over 100,000 miles, and the seats and links are good—once having had repairs.

In regard to the consumption of fuel I must say there is a difference in favor of the balance valve, but am not prepared to say just what the difference is, as the quality of our coal has been changed so often and our trains vary so much that it has been impossible to arrive at any satisfactory conclusion on this point. Engines with the balance valve will haul their trains much easier, apparently, than with the common valve. The cost of balance valves as made in our shop is $45.00 per set. The alterations usually required are new steam-chest covers, costing about $25.00 additional.

Hoping this hasty statement may be of some service to you, I remain, Yours, truly,

A. J. STEVENS,
General M. M. Central Pacific R. R.

SACRAMENTO, CAL., March 25, 1873.

HOWARD FRY, ESQ., *Supt. Motive Power G. T. R. R.:*

DEAR SIR—Your letter of February 22d was duly received. In reply I inclose you drawings and specifications of my valve; also statement giving number and dimensions of engines using it on the Central Pacific Railroad, and the mileage they have made without repairs; also statement from engineers of locomotives and steamboats who have used it during the past seven years. I think the drawings and specifications will require no further explanation from me. You will see by the statement that very few of the engines using this valve have received repairs either to valve or valve gearing. You remark in your letter that you have beeen informed that balance valves do not work well in coal-burning engines. I can see but little

›e between wood or coal burners in this respect, and do not to say that I believe any and all of our balance valves (with ›are) will run from 50,000 to 60,000 miles without repairs. o say that you was afraid your report would look like a ›f the particular valve you are using; so thought I that my ıt might be so construed, and consequently have backed it the proof I have.

ıg this statement may be what you desire, I would request will send me at your convenience a drawing of the valve you g, I remain, Yours, truly,

A. J. STEVENS,
General M. M. Central Pacific R. R.

MARCH 1, 1873.

e undersigned Locomotive Engineers on the Central Pacific Rail- e used A. J. Stevens' Patent Balance Slide Valve on engines under ;e. We have found them to effect a great saving in friction, wear of alve seats, and valve gear; also very much lessens the labor in our engines. We would greatly prefer it to any other "slide e have ever used or seen.

SIDNEY BLISS, Engineer Engine 89.
GEORGE BABE, " " 173.
S. JOHNSON, M. M. Visalia Div., formerly Eng'r Eng. 94.
WILLIAM SCOTT, Engineer Engine 94.

C. S. BLACK,	"	"	35.
E. H. LITTLEJOHN,	"	"	153.
J. E. SAULFAUGH,	"	"	71.
G. D. POORMAN,	"	"	39.
H. S. SMALL,	"	"	96.
J. F. STARK,	"	"	176.
GEO. E. BOOTH,	"	"	155 and 162.
JAS. BATCHELDER,	"	"	3.
GEO. W. JOHNSON,	"	"	172.
SAM. C. CLARK,	"	"	162 and 150.
GEO. H. HUNT,	"	"	66 and 172.
A. HARRISON,	"	"	156.
D. F. WARREN,	"	"	75.
SAM. HENSEY,	"	"	70.
P. T. BOLSEN,	"	"	137.
E. V. HALLOCK,	"	"	122.
C. C. OWENS,	"	"	125.

San Francisco, March 11, 1873.

A. J. Stevens, Esq., *General Master Mechanic Central Pacific Railroad:*

Dear Sir—A propeller of our Company, the "Reliance," gave us a great deal of trouble by the breaking of the valve stem and its connections, so much so that wehad to carry duplicate pieces. This was caused by the large size of the slide valve and great pressure of steam on it.

To try and overcome this difficulty we substituted one of your balance slide valves, and for a considerable time it has been in use and to our entire satisfaction. We have not had any trouble with the valve or its gear since.

I cheerfully commend your valve for all engines using slide valves, and believe it will soon pay the expense of its introduction in the reduction of friction, ease on the valve faces, and saving of power.

Most respectfully yours,

GEORGE K. GLUYAS,
Supt'g Engineer Steamers C. P. R. R. Co.

NOW USING AND BEING FITTED WITH

A. J. STEVENS' PATENT BALANCE SLIDE VALVES.

No. of Engines	ENGINEERS.	Cylinders. Diameter	Cylinders. Stroke	Drivers. No.	Drivers. Diameter	BUILDER.	Coal or Wood.	Passenger or Freight.	Date Bala'ce Slide Valves Put into Engines.	Mileage of Engines without Valve Seats being faced or Valve Gear repaired	Total Mileage of Balance Slide Valves on Engines to date, March 1st, 1873
3	J. Batchelder	11	22	4	4.6	S. F. & A. R. R.	Coal	Passenger	1868	75,400	75,400
15	Van. Audle	18	22	4	4.6	D., C. & Co.	"	Freight	August, 1871	44,988	47,669
35	C. L. Black	16	24	4	4.6	Norris	"	"	March, 1872	28,700	28,700
39	G. D. Poorman	18	24	6	4.6	McKay	"	"	October, 1872	11,255	11,255
66	G. H. Hunt	16	24	4	5.0	"	"	Passenger	February, 1871	64,749	64,749
70	Sam. Hensey	18	24	6	4.6	"	"	Freight	"	60,140	60,140
71	J. Saulfaugh	18	24	6	4.6	"	"	"	December, 1870	55,200	55,200
75	D. F. Warren	18	24	6	4.6	D., C. & Co.	Wood	"	August, 1871	49,608	49,608
89	Sidney Bliss	18	24	6	4.6	Rhode Island	"	"	March, 1872	29,264	29,264
94	Johnson & Scott	16	24	4	5.0	McKay	Coal	Passenger	January, 1871	50,682	74,512
96	H. S. Small	15	24	4	5.0	"	"	"	October, 1871	33,415	33,415
122	E. V. Hallock	16	24	4	5.0	Globe	"	Freight	April, 1872	26,364	26,364
125	C. C. Owens	16	24	4	5.0	"	"	"	"	23,030	23,030
137	P. T. Bolger	16	24	4	5.0	Rhode Island	"	"	February, 1871	36,934	36,934
150	Sam. Clark	16	24	4	5.0	McQueen	"	Passenger	March, 1872	15,654	15,654
153	E. H. Littlejohn	16	24	4	5.0	Rhode Island	"	Freight	September, 1872	16,750	16,750
155	G. E. Booth	16	24	4	5.0	"	"	Passenger	December, 1872	9,100	9,100
156	A. Harrison	16	24	4	5.0	Rogers	Wood	"	July, 1871	64,148	64,148
162	Booth & Clark	16	24	4	5.0	McQueen	Coal	"	March, 1871	69,401	69,401
172	Johnson & Hunt	16½	24	4	5.6	Norris	"	"	May, 1870	48,901	48,901
173	George Babe	17	24	4	4.6	C. P. R. R.	"	Freight	November, 1872	8,975	8,975
176	J. F. Stark	11	22	4	5.0	S. F. & A. R. R.	"	Passenger	March, 1865	78,630	133,730

Engines 15, 71, 94, and 176 only have had valve seats faced since running with "Stevens'" Patent Balance Slide Valve.

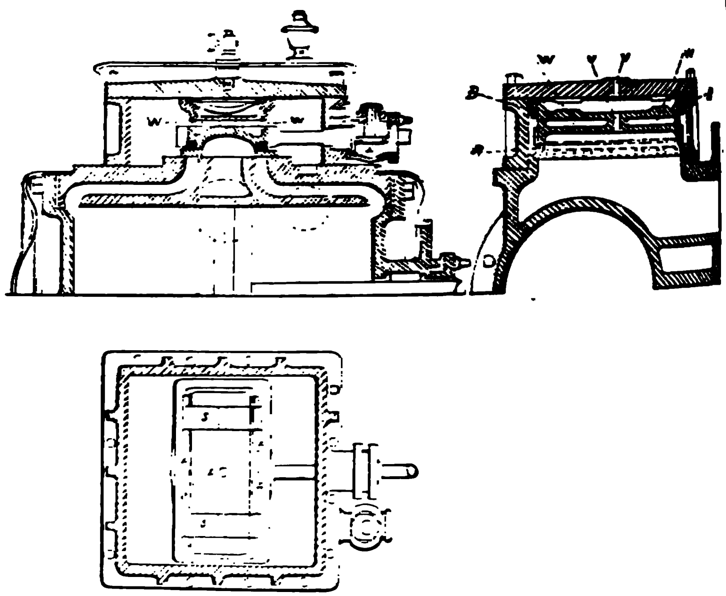
The following Engines are being fitted with "Stevens'" Patent Balance Slide Valve. Have made no Mileage.

No.	Dimensions.				Builder.	Coal or Wood.	Passenger or Freight.
12	17	24	6	4.0	Mason	Coal	Freight.
14	18	22	4	4.6	Danforth, Cook & Co	"	"
49	18	22	4	4.6	Grant	"	"
61	16	24	4	5.0	McQueen	"	Passenger.
62	16	24	4	5.0	"	"	"
97	17	24	4	4.8	Rogers	"	Freight.
154	16	24	4	5.0	Rhode Island	"	"

Also ten new freight engines, 17 by 24, now building, are being fitted with "Stevens'" Patent Balance Slide Valve.

A. J. STEVENS,
General M. M. Central Pacific Railroad.

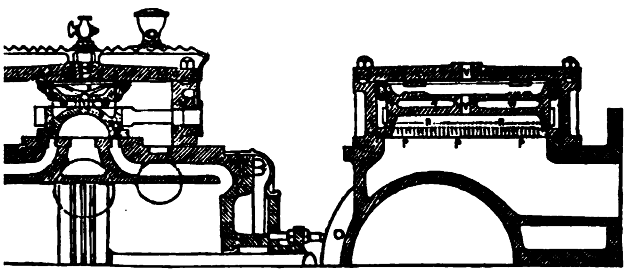
A. J. Stevens' Balanced Slide Valve.

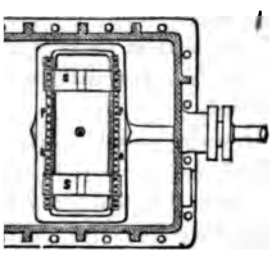


A, Air Valve; *B*, Balance Yoke; *T*, Type Metal Packing Ring; *S*, Springs; *W*, Steam Way; *R*, Relief Valves; *V*, Vent Holes; *P*, Passages to Relief Valves, R. R.

SCALE ¼ of an Inch

ıs for Making and Using A. J. Stevens' Balance Slide Valve.





ıch air valve of the common globe check valve pattern. This valve is lmit air to the cylinders when the engine is moving without working steam, l cases be used with this valve.

ance yoke fitted around the top of the valve and working steam tight er surface of the steam chest cover, and should be fitted so as to be moved ly.

gs fitted into pockets in balance yoke, and resting on back of valve for the ding the yoke to its seat when steam is shut off. They should be adjusted yoke B just up to its seat without causing friction. Whenever necessary to it only requires a piece of thin copper put under springs S S.

etal ring cast in place, and is intended to make a steam tight joint between ;, and at the same time allow yoke to yield to expansion and contraction. ıde wide at the base, so as to make a tight joint when pushed up by pressure

n way through the valve for the purpose of allowing steam to pass freely d of steam chest.

ef valves, and P P are passages to relief valves. These valves are simply ch square iron, having ⅛ inch lift. The air passages are drilled through the ılves are intended to relieve the piston of all back pressure when the engine ıout steam.

hole communicating with exhaust cavity of valve, and is intended for the ;eam or air that may find its way to the back of valve.

EAST ST. LOUIS, February 15, 1873.

HOWARD FRY, Esq., *Committee on Valves:*

DEAR SIR—I received your circular in relation to Balance Valves and General Valve Motion. I have had no experience with balance valves, never having seen any plan of balance or roller valves that I considered had merits sufficient to justify me in trying them on a locomotive engine, prefering that others who had more faith in them should demonstrate their practicability. I would, however, call your attention to my Improved End-bearing Valve that I have been using for eight months with satisfactory results, and in my judgment does away to a great extent with the neccessity of a balance valve. Inclosed you will find drawing and specification, also photograph of my Improved Slide Valve; and I think from them you will see at once what my improvement and claim is. You will see a difference in the valve in photograph and drawing.

In the first valve, as shown in drawing, I used a long opening or port through the valve with bridge bars across it to strengthen it. In the photograph you will see I have the same length of port or opening on face side of valve ⅜ inch deep from face, perforated with 15 ¾ inch round holes, which is more area than is required to admit all the steam you can get into a 16 or 17 inch cylinder under any circumstances in practice. I have adopted this plan in preference to the first one, as being more simple and requiring but little work to change the old pattern of valve. All that is necessary to change the old pattern of valve is to nail on each end of valve a strip of wood sufficient to lengthen the valve to the desired length, which may be from 1½ to 2 inches, according to the room you have in steam chest. In Baldwin engines I am using a valve two inches longer on each end, with ¾ inch port and 1¼ inches bearing bar. On Grant engines I reduce the bearing bar to 1⅛ inches with ¾ inch port through valve. Nearly all the different builds of engines will admit of this change without any change in steam chest. The photograph was taken from the valve I am using on Grant engines. If you cut off valve at points marked red on photograph you have exactly the old valve. So much for description.

I will now give you a little of my experience with the valve.

first engine that I put them in was a passenger engine No. 74. had a miserable set of cylinders on her, and was giving me a t deal of trouble with her valves, and would not run more than ı four to six weeks without facing valves and seats. I put a set he new valves into her on the 4th of July last, and she has been ing steady since that time, and does not now blow any through valves. I have seven other engines running with the new es showing the same beneficial results. I have also five engines ing with the old valve on one side and the new valve on the r side, four of these five I have had to face off on the side with the valve already, and the new valve remains perfectly tight. I am ing them in this way to satisfy myself in time what the differ- is in the wear of the valve. I have another engine running new valves on both sides, with a difference of opening ugh the valve of 6 holes in each end of valve. One valve has oles and the other 9, all of the same size through the opening he end of the valve. In experimenting to find out if I had gh opening through the valve, I found that 6 $\frac{3}{4}$ inch holes was t all that was required to supply $16\frac{1}{2}$ inch cylinder by 26 inch e, so I put 9 holes in the valve I was experimenting with st 15 in the valve on the other side, and put the engine to . She has been running seven months in this way and doing work. This proves that I have ample opening in the 15 $\frac{3}{4}$ holes which is the number I put into a 14 inch port; it leaves $\frac{3}{16}$ inch of iron between holes to strengthen bearing bar.

would also state here, from experiment and observation, that I atisfied that the new valve takes less power to drive it than it the old valve. I have made a number of tests on this point, the most satisfactory tests I have made showed very little differ- in the power required to drive the two different valves; how- most of the experiments went to show less power to drive the valve. But my strongest reasons for thinking it takes less r to drive it is that the cylinder, seats, and valves show so much rear than the old valve, the engineers also say they can handle engines easier under pressure. So you will see if all this is d I think it is, I have a valve that will run an indefinitely r period than the old valve without facing, at least four or five

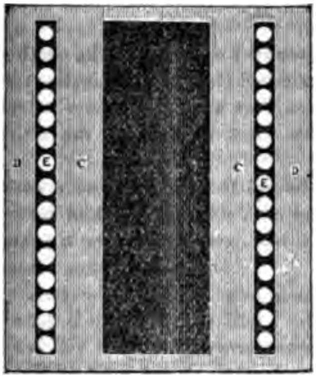
8

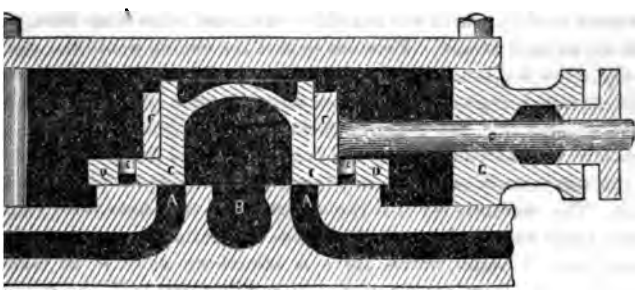
times as long, thus saving repairs and fuel, for engines generally waste considerable fuel before it is considered the valves blow bad enough to face, and a saving in power to drive the valve, I think are three important advantages over the old valve; and its simplicity of application will recommend it to all Master Mechanics. All that is required to make the change being a set of new valves, and I feel justified in saying if they try one set they will never want to put in any more of the old valves.

I have written more than I expected to, but it seems necessary to give you all the points. I would have written sooner, but I have been waiting time to see what the results would be. I have just examined one engine that has run seven months, and from the way it looks and is working I see no reason why it will not run seven years without needing facing. I would like it if you would try one set, or at least one valve on the softest cylinder you have got, between this and our next annual meeting, you will then have a slight idea of its working. Hoping to meet you at Baltimore, I remain, Yours, truly,

H. ELLIOTT, Master Mechanic,
O. & M. R. R., St. Louis, Mo.

Henry Elliott's Balance Slide Valve.





drawing, Figure 1 is a longitudinal section through the valve, steam chest, and the
ıe cylinder contiguous. Figure 2 is an enlarged perspective view of the valve face.
ortion of a steam engine cylinder; B is the valve seat; C the steam ports, and D
ust. E is the steam chest and F the valve stem.
preceding parts nothing new is claimed, and their construction may be modified
rcumstances.
lve G is of the ordinary construction, except that upon each end is a bearing bar,
side the edges I of the valve G, on the same plane as the valve face. The object of
ng bars H H is to increase the length of the bearing surface of the valve so as to
the wear of the valve face and seat B, and give steadiness to the movement of the
n the common slide valve, having variable movement as imparted by the link mo-
locomotive, the seat B becomes hollowed or concave by wear, because the friction
onstant upon the central parts b than the parts b', forming the outside of the steam
ınd this is more especially the case when the movement of the valve is small. In
nce of this the face of the seat wears more at the middle than at the sides b', as
ated. There is another cause of this unequal wear of the seats, namely, the ten-
rock given to the valve by the stem, because its point of attachment to the valve is
tance above the point of resistance or the face of the valve. The unequal wear of
from the latter cause results from the pressure given to the advancing edge at the
g of the movement, the said edge then resting upon the central part of the valve
ıe rocking tendency given to the valve causes the unequal wear of the same, the
and wear being greatest upon the edges I, and, consequently, these edges wear
an the central part, and the face becomes convexly curved. The bearing bars H H
revent this unequal wear by presenting a broader base, which not only has a more
earing on the seat, but overcomes, to a great extent, the tendency to rocking of the
ıd so causes the valve face and the seat to retain their plane surfaces under wear.
nprovement is aplicable to single valve steam engines, where the valve movement
le and can be applied in all cases, without modification of the valve seat, and,
t all cases, without any lengthening of the steam chest.

On motion of Mr. WHITE, of the Evansville & Crawfordsville Railroad, the report was received.

Mr. FRY, Grand Trunk Railroad—I will state to the gentlemen present, in case any of them may have considered their communications overlooked, that two valves were not regarded as they were not balance valves, to which the investigations of the Committee were confined by the action of the Convention.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I sent a communication to the Chairman of the Committee on Valves, giving him some results I had obtained with a valve which I had been using over a year; I thought it would come under the head of "Valves and Valve Gearing." I commenced using this valve about a year ago, and the results are far more favorable than I had expected. I will admit that it is not a balance valve, but so far as requiring facing is concerned, I think it will run as long as any valve that I have ever heard spoken of. I put a set of them on an engine last Fourth of July which has run thirty thousand miles since then, and the valves are as good as new. Previous to that the engine would not run three thousand miles without requiring her valves to be faced off. I have them now on seventeen engines and they are all giving the best results. There is not one of them that has required facing; they maintain the same surface continually. I examined one of the engines before I left home, and I consider the valves more perfect than when I put them in; they were in perfect enamel. The engineers say it is the easiest valve they have tried yet. It is a simple valve and can be made for almost any build of engines at almost a nominal cost. I think, unless there is something more to be taken into account than the mere saving of power, it will answer all the purposes of any valve that I know of. I fixed up five of our engines with the new valve on one side and the old valve on the other. In four months I had to face off the old valves in four of the engines twice, and the other I faced off three times in that time. The new valves needed no facing at all. The valve proves itself just that way. I have one of them with me which any gentleman can see. These are the results I have obtained. Some other roads have tried the valve. If Mr. Hayes were here he would tell you how it has worked on his road. Mr. Gorman has tried it also; perhaps he will give his experience.

Mr. GORMAN, Toledo, Wabash & Western Railroad—Mr. President, I can corroborate Mr. Elliott's statement in regard to the valve he speaks of. Mr. Elliott spoke to me about the valve and I had them put on one of our engines. They were not just as Mr. Elliott desired to have them, and he changed them to suit himself exactly. I like the valve very much. I have tested it several times and find it wears and works well. There is no blow, no leak to it all. It is as good a valve as I have seen perfected. But when you alk of balance valves I have never seen but one that I considered a true

ance valve; that was some twenty-five years ago when I was connected h the Boston & Worcester Railroad. Parker was then Superintendent of road; it was about the time Wilmoth commenced building engines. I s a sort of supernumerary about the shops and was considered a sort of eman although I did not hold that position. Wilmoth was in the habit talking to me about engine building a good deal, and one day came to with an extract from the Edinburgh Review, the Edinburgh Gazette, or ne such paper, giving drawings of a balance valve. He asked me what iought of it, and I told him I thought the design a good one, but had ie few defects which would prevent it from working well under a high ssure. He had some valves made according to the plan, however, and me to try them on an engine. We ran the engine down the road a e, and when the speed was about eight miles an hour the valve worked y nice and smooth; but when we got up to twelve miles an hour she ked hard, and finally the valve piston lifted off the seat and blew ugh. Mr. Wilmoth's face fell. "Why," said he, "the engine has ken down." "No," said I, "it's just as I told you the thing would k, it is your valve; when we get down to a slower speed it will be all it." And so it was; it wouldn't stand a high rate of speed. That igh was the only true balance valve I ever saw, and I do not know why as never improved on.

n motion of Mr. Flinn, of the Western & Atlanta Railroad, the Conven- adjourned to nine o'clock A. M., Thursday.

THIRD DAY'S PROCEEDINGS.

he Convention met at 9 o'clock Thursday morning, May 15th, President ton in the chair.

r. Fry, of the Grand Trunk Railroad, moved that Mr. Jerome Wheelock, Vorcester, Massachusetts, be requested to read to the Association a r which he had prepared on the subject of "Valves and Valve Gear-

e motion was carried.

A Paper on Valves and Valve Motions, by Jerome Wheelock, Worcester, Mass.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Choosing from the subject matter to be discussed at this Convention, I have thought proper to take up some of the questions coming under the head of valves and valve motions. Much has been said and written, and much remains yet to be said, it is not therefore my purpose to exhaust the subject, or your patience, but to present to the Association some of the results of observation, and perhaps make suggestions, that will provoke further discussion on this most important subject.

With all its defects it must be conceded that nothing has yet been introduced that has so well answered the purpose of controlling the induction and eduction of steam to the locomotive cylinder as the ordinary flat slide valve, nor does it at present seem probable that it ever will be superseded. From its early history, down to the present time, theories innumerable have been advanced and worked out as to the proper proportion of valve, port, and throw, until one might almost say that as many distinct notions exist as there are men connected with their use. All can not be right, and I question whether any one arrangement, as used at the present time, is not susceptible of considerable improvement in its details.

On the introduction of the "link motion," more especially of late years, those who have had charge of the construction of locomotives have seemed to favor long ports, thereby materially increasing the surface of the valves and their seats. Indeed, this has been carried to such an extent that it is no uncommon thing to find ports of locomotive cylinders sixteen inches long, with widths varying from one and one-fourth to two and one-half inches, and this too on cylinders not over sixteen inches in diameter. To make a valve to cover these vast proportions and carry out the various notions as to lap and movement, necessarily calls for the throat, or under cavity, with an area of about sixty-five square inches. I believe it is well understood among my associates that it is to this cavity we may look for the cause of hard-working valves, as it is well known that with no outlet

from the under side, it matters not what the pressure is in the steam chest, the valve will move with perfect ease.

Here then we have the root of the difficulty, to overcome which much valuable time and thought have been expended. Experiments with so-called "balanced valves" have been "legion," and the results, if we may believe the statements of those interested, have been truly wonderful. I have listened to statements where one of these inventions has effected a saving of thirty-three per cent., besides a great saving in wear and tear of the valve gear; but up to this time I do not believe it possible to show by actual test any case where, after having given the ordinary slide its proper porportions and adjustment, a fair comparative trial has resulted in any saving of fuel or material in favor of the balanced valves. On the contrary, I am fully persuaded that the opposite is the result. I know I am on "ticklish ground," and some of my associates will question these views; but, gentlemen, I have had the disease. I have been through with a series of experiments to demonstrate the value of balanced valves for locomotives, and I assure you the dose has entirely cured me.

My early acquaintance with the locomotive led me into the common error that a very great amount of the power of the engine was being absorbed to move the valves; in fact, it appeared to me to be self evident. As figures would not lie, it was easy enough to make out a case. Taking the area of the surface of the valve, multiplied by the steam pressure per square inch, made the sum total of the load to be moved perfectly enormous. To stand by and see the valve gear shake as an engine was leaving a station was, it appeared to me, sufficient to satisfy any one.

I was made aware that the subject was not new, as upon my becoming an inventor in this direction my attention was called to between thirty and forty different devices gotten up to relieve the pressure on the valves. Many had been tried and some had not; and I will here say that some of these devices are marvels of genius, complicated though they may be they yet have occupied some of the best brain power of this nation.

Bear with me while I give you a brief description of my invention. Believing that circular fits could be more perfectly made and

controlled, I at once adopted the rotary principle. My valve chest may be described as a cast iron cylindrical casing, provided on its upper side with an inlet for steam-pipe connections, through which steam passes to an annular chamber, surrounding an inner shell, the axis of which, being at right angles with the bore of the cylinder and being bored conically, forms the seat of the valve. Into this conical seat I fitted a double-ported, double-seated valve or plug of corresponding shape, making the taper about one-half an inch in its entire length. Bonnets, or covers, were fitted to each end of the casing, which were used to support the plug, on hardened steel bearings, on which it was supposed the bearing would principally come, steam being admitted to the cylinder through each end of the plug, as it was alternately moved by a stem projecting outside, on to which was keyed a crank that received motion from the valve rod. In order to control the position of the plug and make adjustment easy I placed a nut and check nut on the valve stem, arranged to bear against the outside surface of the bonnet, and when the engine was using steam a slight end pressure brought the nuts up to a ground seat and obviated the use of a stuffing box, or packing. The exhaust was effected by cavities on the periphery of the plug, very much in the usual way, there being two cavities, one on each side, connected.

After perfecting, as I thought, the details of my valve, and receiving considerable encouragement and flattering expressions that I had hit the nail this time sure, I commenced its introduction. Castles in the air were numerous, most of them with French roofs. The field was immense and success sure. A number of New England roads had signified their willingness to aid in its introduction, and terms were made, but owing to temporary inconvenience in furnishing the trial valves it was decided to make one trial at a time. An engine was selected on one of our prominent roads and the valves applied. When the time arrived for the engine to come out of the shop my anxiety was at its height. I had made some discoveries that did not suit me. I had found out that the record kept of the engine showed her consumption of fuel to be less than three thousand pounds of wood per day. This seemed to me a very small amount to test my valves against, but relying on the large

amount of power I was to save I felt assured the valves would win.

The engine came out, and as she was moved up and down the yard everything seemed to work as it should, and she was attached to a freight train and the trial began. Using steam quite freely for the work performed, it was suggested that the engine was just out of the shop and was stiff. It was evident the *valves* did not go hard, as the reverse lever could be handled with perfect ease. If the latch was raised out of the notches the lever would stand at any point without holding—a result I considered very satisfactory. Arriving at the first descending grade steam was shut off as usual, when it was expected speed would increase by the force of the train. This, to my surprise, was not the case. The engine was indeed "stiff." Steam rapidly accumulating the furnace door was opened, when a very strong exhaust was discovered, drawing hard on the fire, and the fire box was soon emptied of the fuel, the engine blowing off violently. I will here remark, that my valves were allowed an end play, or movement of about one-half an inch, working away from their seats when steam was shut off. This I had expected would be sufficient to relieve the engine when running down grade. I was greatly surprised at this result, as were my companions. Where all this exhaust came from was a mystery; but as it made the engine steam well, I tried to persuade myself and others that it would result to an advantage.

The round trip having been made, and several promiscuous trials on different trains gone through with, the engine was at length put upon her accustomed passenger train. Here the comparative trial began; and, sparing your patience, I will say that after about a year's use the trial ended. I might talk to you a week, detailing my experiences during this time.

The engine "blowed," and the valves must come out and be looked at. When taken out they had the polish of a mirror. Anti-compression and relief valves were put in, and changed this way and that way. One day one thing and the next day something else would suggest itself as being necessary to make the engine better. I will here remark, that I was in the hands of friends. Never were men more anxious for success than were the officers of that road

that those valves should succeed. Every facility was furnished and every assistance rendered that could be. The engine was taken off her train while I applied a second pair of valves with some of the details changed. And thus I *worked*, and *tugged*, and *studied*, until I nearly wore myself out during that year, all to no purpose, trying to make that engine do as well as she *had* done with her old valves. I am fully persuaded that the trial was as exhaustive an one as has ever been made in this direction, and I verily believe the results were as favorable to balanced valves as any that were ever tried; but still the verdict *must* be that the engine did not do as well as with her old style of valve.

I have thus somewhat minutely described my valve and the trial, I will now proceed to give you the conclusions deduced.

First, that every addition of a single piece to the locomotive valve, or its attendant parts, that is not actually required to make the engine work better, is a positive step backward.

Second, that considering the fact that a very considerable pressure exists on the exhaust side, and is made necessary for blast when the engine is moving at the ordinary rate of speed, makes any further balancing of the valves practically unnecessary.

Third, that it is far from beneficial to any part of an engine to draw in cold air, through anticompression or any other valves, when the engine is moving without steam, and discharge the same up the smoke stack, as such operation turns the locomotive into a regular air pump, causing unnecessary wear on the connections and other moving parts, and unnecessarily fanning the fire.

Fourth, that it is quite important that the valves of a locomotive be so arranged as to allow of free circulation from one side of the piston to the other, when the engine is in rapid motion with steam shut off, and that this result is successfully attained by allowing the ordinary flat slide valve to raise from its seat, which can be done to a reasonable extent without injury.

There are several reasons why balanced valves are not practical for the locomotive. High pressure steam is a terrible searcher, and will find the minutest outlet. It affects metals variously at various pressures. Expansion and contraction of metals are among the evils to contend with. Thus, while a pair of valves might be practically

ight at sixty pounds, they would be found to leak badly at one ıundred and twenty pounds pressure. The walls and cover of the team chest subjected to great strain are warped, more or less, and o not remain absolutely as when fitted. Then comes the wear. But perhaps it will be argued there *is* no wear with the valves balnced. Ah! gentlemen, this is preposterous, as you could not wipe woolen cloth over the surfaces the number of times the valve is ıoved without perceptible wear. But enough of this.

Let us examine for a moment some of the advantages and defects f the ordinary slide. That so many desirable features can be conentrated in a flat piece of metal, with a D shaped cavity in its nder surface, excites my most profound admiration. The valve ıay be said to be the vital principle of the engine. It controls the utlet to the coal and wood pile. It is of the highest importance ıat it work practically tight under all circumstances when the ngine is using steam. No one thing so injuriously affects an engine s leaky valves, and while it is, I believe, practically impossible to et a balanced valve that will work and remain tight for any length f time, it is quite an *easy* matter to accomplish this result with the at side. An ordinary skilled workman with a little practice and a craper is able to take a pair of valves from the planer and make ıem absolutely tight in less than one day's time. Indeed, some uestion the necessity of scraping at all, claiming that with properly laned surfaces the valves will make their own seats perfect. But I uestion this theory, as I believe it pays to have the valves and ıeir seats perfect in the commencement of service, and when proprly fitted and proportioned, of the right quality of metal, how eautifully they work.

I have in my mind at this time, an engine hauling an express ain on one of our fast lines where the valves were found to be ractically tight after twenty-three months' constant service, and hen the engine was taken in for repairs it was a somewhat difficult uestion to settle, whether anything could be done to improve the ondition of the seats. And here I desire to say a word about the eglect, oftentimes practiced, of allowing an engine to come out ithout refacing the valves. It is no criterion to go by that the surces have a nice, smooth appearance. This is usually the case

when a casual examination would suggest "good enough," but if planed off positive defects would be discovered. Indeed, it has occurred to me that it might not be a bad plan to have duplicate valves of exactly corresponding dimensions for each engine, which could be kept in reserve, with nicely planed surfaces, and at stated intervals of service remove those in use and insert those in reserve without detaining the engine. It seems to me that it would result in keeping the seats in true condition for a much longer period, and perhaps avoid much of the "blowing" now going on.

Another important matter is usually lost sight of. I refer to the metal used in constructing locomotive cylinders. I believe it is of the highest importance that the right grade of iron should be used. The want of care in this direction those who have charge of the repairs on our engines can attest. Gentlemen, if you would demand that the best charcoal iron be used in your cylinders—yes, I am going to suggest that you go further than this—that you demand that the valve seats be cast on a chill, if you would do this I believe you would make long strides in the right direction. But, do you ask, how shall the seats be faced? This is an easy problem, as with the present perfected arrangements of emery grinding wheels and apparatus every variety of hardened surface is finished at will. Indeed, the emery grinder is superseding the planer on soft work where exact nicety is required. I believe these suggestions can be successfully carried out without materially increasing first cost or trouble.

Another defect and prolific cause of trouble is the extreme length of the steam ports. In a somewhat extended observation I have formed the opinion that three inches is about the maximum diameter of the double exhaust tip. Many engines use less, and few if any use larger. Here we have an area of a trifle over seven square inches for the exhaust. I am fully persuaded that no trouble exists, if it is generated fast enough, in getting the steam into the cylinder. That will generally take care of itself if we take care that the exhaust is right; of course we must provide for our draft or the engine will not steam, and it seems inexorable that the exhaust tip must be contracted. Allowing this to be so what advantage can come of the large increase in area of the ports? Sixteen inches

long and one and one-fourth inches wide give us twenty square inches in each port, and a very disagreeable state of things to take care of, as most of you know. Why make the ports so large when the tips must be so much smaller? You can, if you please, have all the passages enlarged as much as space will allow of except under the valves. I verily believe we can contract the steam ports of any locomotive in use to-day—I refer to the largest, to twelve inches in length—without in the least affecting their ease of action, and very materially relieve the valves and movements. It is no uncommon remark among those connected with the use of the locomotive, that our engines are not as "smart" in proportion to their size as they used to be. You will hear men tell what they used to do with the smaller machines of days gone by, and how it bothers the larger ones to do the same thing now. This may result somewhat from prejudice; but we are forced to admit there is too much truth in the statement, and it is getting to be time we found out the cause. I believe if any one thing more than another is chargeable for it it is the link motion. The simplicity of this invention has hung like a ball and chain attachment to the minds of most of us who have had to do with locomotives.

I have about made up my mind that, as a movement to effect the cutting off of steam to be used expansively, it never was nor ever will be an economical arrangement for the locomotive or any other engine. To allow the half expanded steam to escape before the piston has completed half its stroke, is not, in my opinion, what is wanted, nor is the premature closing of the outlet in the face of a rapidly advancing piston, thereby creating an immense compression, desirable. On the other hand, it is an expensive result that follows the link whenever it is used as an expansion valve gear. Of course simplicity is desirable, but are we not paying too dear for it in the indiscriminate use of the link? There can be no objection to its use as a full stroke valve motion; indeed, I think it is as well as can be in this capacity, but when you move it from its true position of full throw, and use it as an expansion valve gear, the results are not and should not be satisfactory. I am confident the time is not far distant when something will be produced that will obviate these objections. I shall not attempt its description at this time.

I promised you at the commencement I would not exhaust the subject. I have already trespassed too much on your valuable time, and, conscious that imperfections both of omission and commission have a place in the foregoing, I yet rely on the indulgence of friends, and am stimulated by a sincere desire, in common with my associates, to see that noble machine, the American locomotive, brought up to a higher state of perfection.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I move the paper be received.

Carried.

THE PRESIDENT—The Secretary informs me that although Mr. Dohoney's name does not appear on our registers, he has our former Secretary's receipt for ten dollars. What action will the Convention take on the subject?

Mr. FRY, Grand Trunk Railroad—I move that the gentleman be considered a member of the Association.

The motion was carried.

Mr. Philbrick, of the Maine Central Railroad, presented the following report from the Committee on "Machinery and Appliances for Removing Snow from the Track:

Machinery for Removing Snow from the Track.

To the American Railway Master Mechanics' Association:

GENTLEMEN—The subject assigned to your Committee is in several respects peculiar. Snow is confessedly a "northern institution," and hence the matter is one of sectional interest. To many of the members of this Association a snow plow or a flange scraper would be even a stranger thing than to others would be a cotton gin or a cane crusher. But while the subject has a necessary interest for only a minority of the roads here represented, to those which are interested in it the matter is one of very great importance, since it has to do with an obstacle to railway operations of very formidable character, and requiring for its removal very powerful agencies and most energetic measures.

Another peculiarity of our subject is that the obstacle whose removal is contemplated is one of exceedingly variable conditions. While in some places the snow rarely exceeds a foot in depth, with a moderate temperature and little wind, in others it lies on the

round continuously for four or five months, attaining an average epth of five or more feet, with high winds and a temperature often f many degrees below zero for several days in succession, the wind ften piling the snow in drifts of ten feet and upward in depth, and xtending for long distances, and in combination with the extreme old compacting it into a solid mass so hard as to bear up the weight ' a horse. Again, the drifted snow fall is at times followed by rain, nd this by a sudden fall of temperature leaving every thing covered ith a crust of ice an inch or more in thickness; or, again, where e amount of snow is not great but where high winds prevail, comg over a broad level country, bringing along with the snow large antities of sand or soil, the excavations are filled with a mixture ry hard to break.

The responses obtained by your Committee to the interrogatories ued by them present every variety of character; from those of the uth, which summarily declare "We never saw a snow plow and ver wish to," to those which come shivering from the cold districts eaking of snow drifts *thirty feet* in depth. It will be at once vious that the appliances which fully meet the necessities of some aces would be utterly inadequate for others, and those demanded some equally unnecessary in others.

In discussing the means and methods of removing snow from ilway tracks, your Committee would say at once that no device s appeared, or in their opinion is likely to be found, which can successfully substituted for the plow. Others have been invented, odels of two of which have been sent to us. One of these is conructed with a broad shovel edge in front, and a flue running up d back through which a belt with flat scoops attached is made to volve, by which it is proposed to take up the snow, carry it up the e, and by a revolving disc behind to throw it off on either side. e other, Mr. Griswold's "Air Snow Plow," is designed by means a current of air, produced by blowers, to drive the snow taken up m the front through a curved pipe and discharge it on either side the track. These, however, if practicable to any extent, it seems us must be very slow of operation, and only practicable in very ht snow which could be easily penetrated by a plow.

PLOWS.

In those places where the snows are light and not liable to be drifted or compacted by winds and cold, a simple prong plow attached to the pilot, or a modification of the pilot itself, followed if necessary by a flange scraper to prevent the compacting of snow on the inside of the rail is found sufficient. In other places where although the amount of snow is not large, yet from the low temperature and high winds it is driven, mixed with sand or soil, into hard but not deep drifts along the track, the only modifications of the plow required are increased strength, a more elongated and sharper share to cut, and by lifting to break up the compacted mass that it may be thrown off by the sides. In this case the flange scraper to follow the plow is a more essential requisite.

But it is with the extreme condition that our theme has chiefly to do. How shall we clear and keep clear the track in those parts where the snow lies on the ground four or five months, attaining an average depth of from three to five feet, and where, under the influence of intense cold and high winds, drifts of compacted snow are formed of five to fifteen feet in depth? Here, although not strictly included in our subject, the matter of precaution should be considered, as the first law of health is to avoid disease, the first requisite for a clear track is to use all practicable measures to prevent the formation of drifts, for it is these that cause the chief trouble. If snow would but lie still and of uniform depth, its disposal would be a matter of comparatively little difficulty. It is a thing of prime importance then to guard those points peculiarly exposed to drifting by one or more rows of high substantial fence, by thickly set hedges of evergreen trees, or whenever necessary by construction of sheds. Though expensive, yet in view of the inconvenience, losses, and great damage to machinery, which even a single severe storm may entail, any reasonable expenditure on these would be an economical outlay. The importance of this consideration may be inferred from the fact that by severe storms of the last winter some of our New England roads had from ten to thirty per cent. of their engines disabled within little more than one week. Another important precaution is particular attention to the condition of the track, especially

›ints where drifts are likely to be met in order that the clear-
hinery may work with most efficiency and to diminish the
of running off.
'wdrift is an obstacle to be got rid of, and that as expedi-
ıs possible. The question of its removal becomes one of
ıd so of strength in the means employed. There is no
y for the removal of a snowbank within the required time,
an do little more than to determine the fittest forms of im-
for attacking the obstacle to greatest advantage, and skill,
n the construction of the implements, is of use mainly in
; the tactics of assault.
arious styles of plows in use may be resolved into three

ıarate structures resting on truck frames placed within their

ws attached to heavy cars, within which men may be carried
e them;
ws attached to engines.
: first many are in use on New England roads, and it is the
l employed on the M. C. R. R. One style, a drawing of
:companies this report (see Drawing No. 1), has its sides
nd carried forward at the top so that as the snow is lifted it
together and thrown off at the sides to a distance propor-
› the velocity of motion. This plow does not allow the
go back upon the engine, and has been found to work well
e banks are not too high to allow it to discharge itself freely
ides. For deeper snows and for breaking through drifts, a
similar construction without the curved top is employed.
n, of course, does not leave so clean a track as the other.
e attached to the engine by a light shackle of $\frac{5}{8}$ inch iron,
' the plow should leave the track may break and allow it to
self from the engine. No men are placed upon these plows,
:e there is no special exposure to injury. Mr. Thompson,
'astern Railroad, on which this kind of plow is used says:
ve experimented with plows of various sizes and shapes,
› decided that plows with a single pair of wheels forward
t behind, with a wheel base of not over ten feet, keeps the

track best; that those of eight feet in height and eighteen feet long, with top built forward to within three feet of the bottom, answer the purpose best."

Of the second class one style is the Heywood Plow, of which drawing and photograph are given (see No. 2.) This plow would seem calculated to do its work well, and is highly spoken of by Mr. Keeler of the F. & P. M. R. R. We have also two excellent drawings (Nos. 3 and 4) from Mr. Cushing, of the N. P. R. R., of plows attached to cars such as are employed on that road. A peculiarity of these is that the plows rest upon trunnions, having apparatus attached by which the nose can be elevated a foot or more, which arrangement would seem to afford some advantages, especially in backing out from drifts preparatory to a second run.

The third class of plows—those attached to engines—embraces of course all the smaller kinds used where but little snow occurs, but of late very large plows of this description have been brought into use for heavy work. Mr. Waugh, of the K. P. R. R., furnishes a drawing of one employed upon that road (see Drawing No. 5) which is nearly ten feet in extreme height and extends about eight feet in advance of the engine, with bearings near the nose for resting on the rail. Mr. Cushing, of the N. P. R. R., sends drawings of two sizes of attached plows, one (see Drawing No. 6) for light work of four feet nine inches in height, and another for heavy work (see Drawing No. 7) which is eight feet six inches high, and extends forward about six feet six inches, with bearings upon the rail. Of the performance of these plows both gentlemen speak in very high praise. Mr. Waugh says: "These plows are decidedly the best that have been used for all purposes." He adds that one of these can be removed and pilots attached by two men in two hours, cost $714. Mr. Cushing says of the larger of his attached plows: "This is the favorite plow with us for all kinds of work. This class of plow, run with two engines, has kept open without serious detention our worst snow district, and made the heavy independent plows unnecessary in consequence of their doing the required work with far less power and greater safety." The district alluded to is described as "running through rolling prairie, with cuttings of from three to fifteen feet and subject to high winds and extremely low temperature—a

mbination which packs the snow to an almost incredible hard-ss." Of the smaller pilot plows Mr. Cushing says: "We use ese on our regular train engines; they work well in snow two feet ep where the old banks have not accumulated to a greater height, d for short distances will run through a much greater depth of ow."

Beyond the statements of these above named gentlemen our sponses contain no expressions of opinion as to the comparative erits of different kinds of plow. These, however, as has been en, are very strongly in favor of the attached plow, and there can e no doubt that for safety and general facility of operating they are uperior to the independent plow. But on the other hand their use ust involve a much greater expense. For every such plow one of he best engines is practically withdrawn for the season from general rvice. The trouble and expense of attaching and detaching must mount to a very considerable item, they must subject the frame and uck springs of the engine to very severe strain. If an engine is isabled the plow is for the time useless. They must also be incon-nient to get into the house and on the table, and when stuck in ep snow more difficult to withdraw than if the engine could be tached from the plow; while the independent plows require the rvice of the engine only when in actual use, can be connected and sconnected as easily as a car, can be more easily withdrawn from ifts and do not need to be housed, or can be run under any elter. The above-named objections to the engine plows, how-er, can all be obviated if their advantages are thought to warrant e increased expense.

DEVICES FOR WIDENING TRACK.

Some plows have devices attached for increasing the width of the th after the plow has been through. The Heywood Plow has an angement of this kind. (See Drawing No. 2.) Wings of about feet in length and height are attached midway of the car, hinged the forward end, and connected with apparatus within the car by ich they can be thrown out to the required width. This plan uld doubtless work well in snow so light and soft as to admit of npression; but where the side banks, as in some localities three

to five feet in height, are hardened almost to the solidity of ice, it would be unserviceable. It seems to your Committee that for these, a hinged flap or wing attached to the outer corner of the shear of the plow, supported by strong braces when raised, and when down flush with the sides of the plow to cut the snow and throw it over, would serve the purpose better.

FLANGE-SCRAPERS.

Besides the plow, another implement is found necessary to remove the snow from between the rails, or for some distance inwardly from each rail. Of these there are two general forms—one taking out the snow for the whole width, and the other consisting of two independent scrapers or cutters, one for either rail, and hung obliquely to its direction, so as to cut out snow for ten or twelve inches and throw it over the rail. One style of the former, which is like a narrow snow plow, and operated in a similar manner, the cutting edge being dropped to the required depth between the rail, must be regarded as dangerous, though in use on some roads, and doubtless effective.

Of the second kind, three forms have come to the knowledge of your Committee. One, the Osgood Flange-scraper, consists of a platform car, having at the middle on each side heavy vertical swing beams, faced at the lower end with iron, and so hung as to be easily raised at crossings, etc., and with springs which allow considerable play if an obstruction is met. The cutters extend over the rail about four inches, and remove the snow for about ten inches in width and one and one-half inches in depth on the inside. This is drawn after the engine and operated by a man on the car.

The Heywood Flange-clearer (Drawing No. 2), similar in principle to the former, but of very different construction, is attached to his plow forward of the trucks of the car, and immediately following the plow, and controlled by the men in the car. This has the advantage of clearing the path of the flanges in advance of all wheels passing after the plow, but is, perhaps, not quite as safe as the former.

Another of similar design (Elliott's patent) is attached to the engine forward of the trucks, and controlled by the engineer. Mr.

Cushing, of the N. P. R. R., speaks of this as very satisfactory in its working. A drawing and model of this have been sent us.

Mr. Griggs, of the N. Y. & O. M. R. R., speaks of a plow in use on that road, very heavy, with wings for widening the path, scrapers in front of the forward wheels, and a flange-clearer on the rear end, operated by men in the car. "We think," he says, "that we have as complete a plow as is made. It makes a clean path of fourteen feet in width when the wings are out." The promised drawings of the apparatus have not been received.

METHOD OF OPERATING.

But few of those from whom responses have been received seem to systematize very thoroughly the matter of operating with the "snow gang," though doubtless all that have much to do in this way employ more method than their replies would indicate. The substance of most of the replies is, "When snow is to be 'bucked,' we take two or more engines with the plow, and *go for it.*" This last expression, indeed, gives the gist of the thing. Yet "the order of the going" is a matter of no small importance. The N. P. R. R. seems to have not only the most perfect equipment of appliances for the removal of snow, but also the most complete system in its method of operations. Printed rules are placed in the hands of engineers, which they are required to observe. The direction of the train is devolved upon one man, and a system of signals is arranged to secure simultaneous action by all the engineers in attacking the snow. No advance is allowed until all are entirely ready, nor without full pressure of steam. When the snow is deep or badly drifted on one side, the conductor or head engineer is required to make careful examination before striking the bank; and when the drift is very hard, the edges are broken with shovels before the plow is run. An extra engine, in difficult cases, accompanies the snow train, and is required to keep one mile distant in full readiness to run up instantly, at a concerted signal, to render assistance. When the train is stuck in a drift, the rear engine is first completely released, which then can aid the others. The rules of this road appear, from the extracts given, to be so judicious that your Committee think they could hardly do

better than embody them entire if space would allow. They can doubtless be obtained on application.

It is found by experience to be unadvisable to attack drifts of eight feet in depth without previous shoveling. And where drifts of considerable depth are much compacted by the wind, the work of the plow may be much facilitated and time saved by cutting trenches across the track, in advance, at intervals of ten or twenty feet. It is doubtful whether more than two engines can be used to advantage in driving a plow. In general, a third engine may be of most service if kept free in the rear to aid in backing from the drifts.

Obviously, no general rules can be given which shall cover all the cases that may arise in snow plowing. Much must be left to the judgment of the conductor of the train. No part of railway operations in the snow districts makes greater demands for the combination of prudence and pluck than this of the removal of snow. Hence care should be taken in selecting for this service men of caution and courage, and fertile in expedients. The grand requisites for the work, then, are a proper plow, adequate force, and A MAN.

No allusion has been made to the removal of snow from doubl tracks. In this your Committee have had no experience, nor is an thing said on this branch of the subject in the letters received. M Heywood furnishes a sketch of a plow for this service, the shear which is substantially one-half of an ordinary plow of double wid Another style has been seen, which is constructed with a flat incl and a fixed center share extending about one-third of the length fr the top. To this is hinged a swinging share, which can be faste on the middle to act as an ordinary plow, or swing to either cor for use as a side plow, in either direction. We know nothing of operation of either.

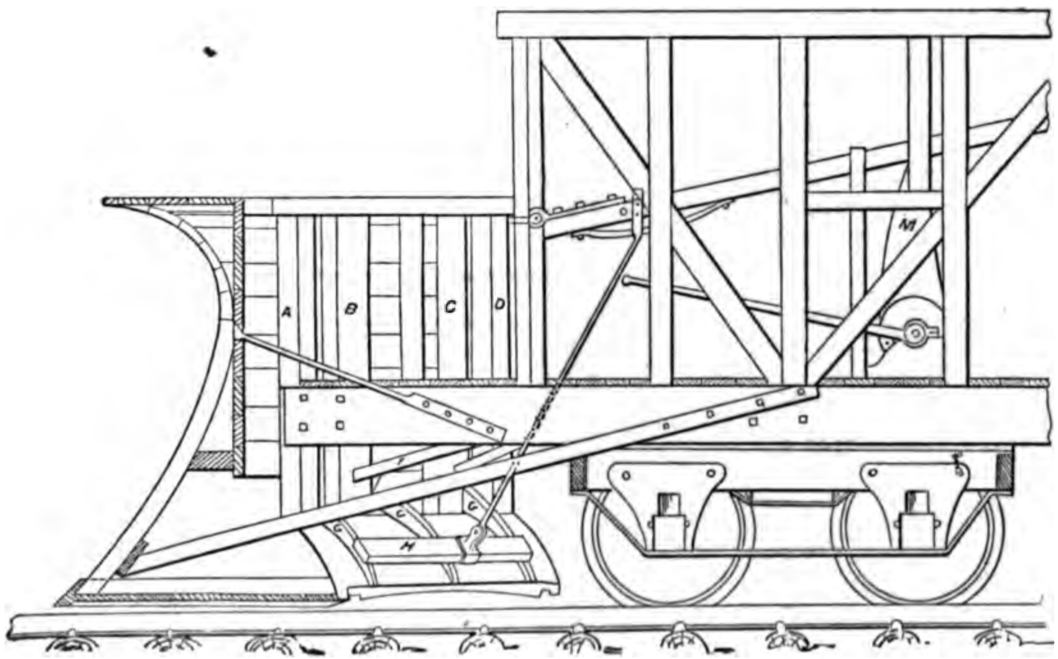
Respectfully submitted,

J. W. PHILBRICK,
J. N. FOSS,
E. STUDLEY,
} *Committee*.

On motion of Mr. Keeler, of the Flint & Pere Marquette Railroad, the report was received.

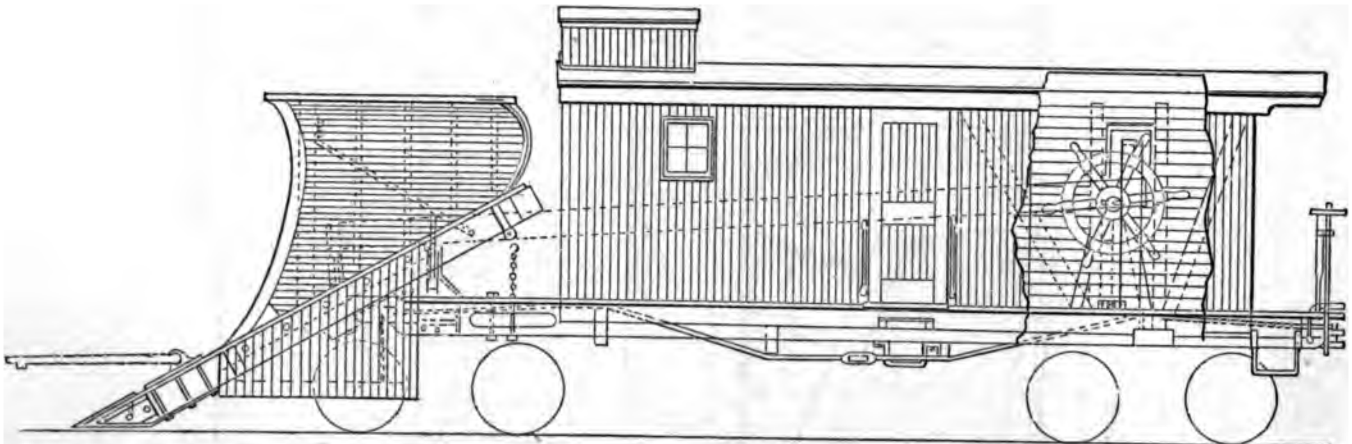
The Committee on the "Best Form and Proportion of Axles for Cars and

C. L. Heywood's Double-Track Snow Plow and Flange Cleaner, used on Flint & Pere Marquette Railway.

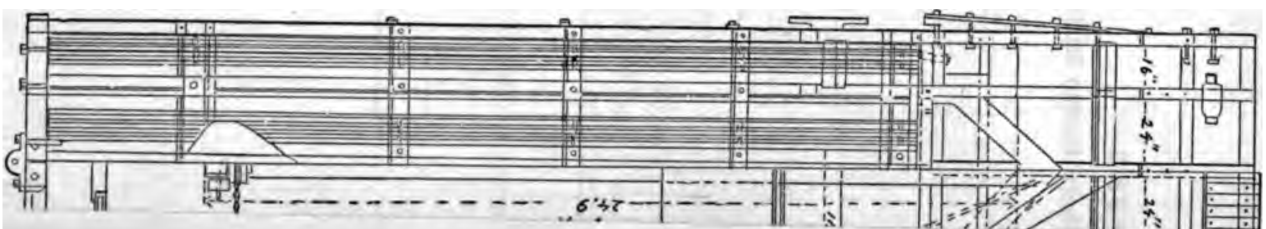


DRAWING No. 4.

Snow Plow Used on Northern Pacific Railway.

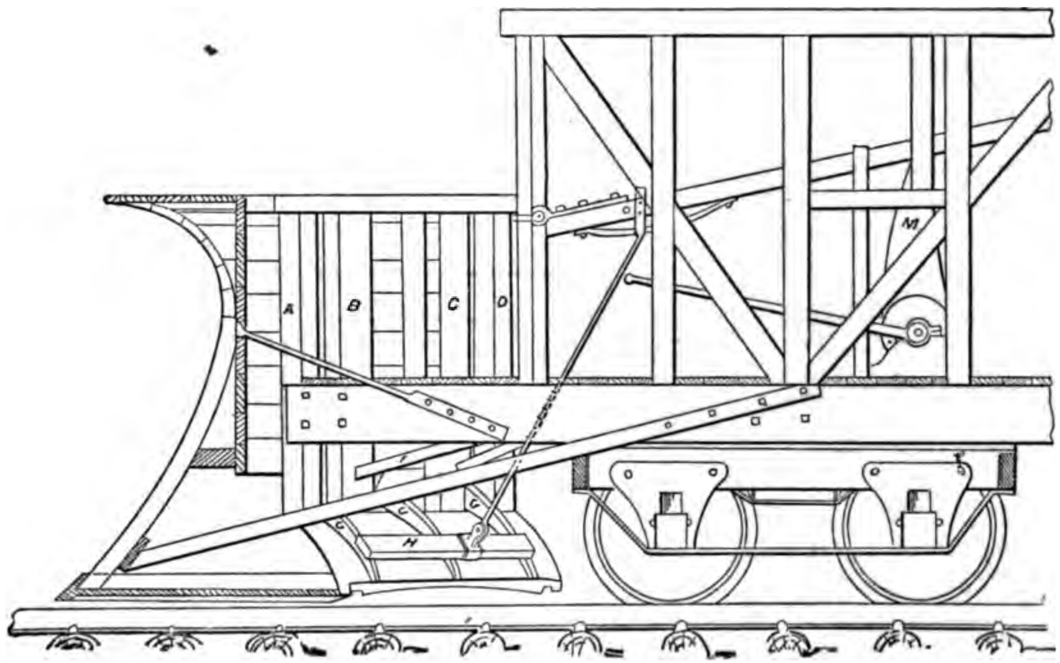


Length of car body 28 feet.



DRAWING No. 2.

C. L. Heywood's Double-Track Snow Plow and Flange Cleaner, used on Flint & Pere Marquette Railway.

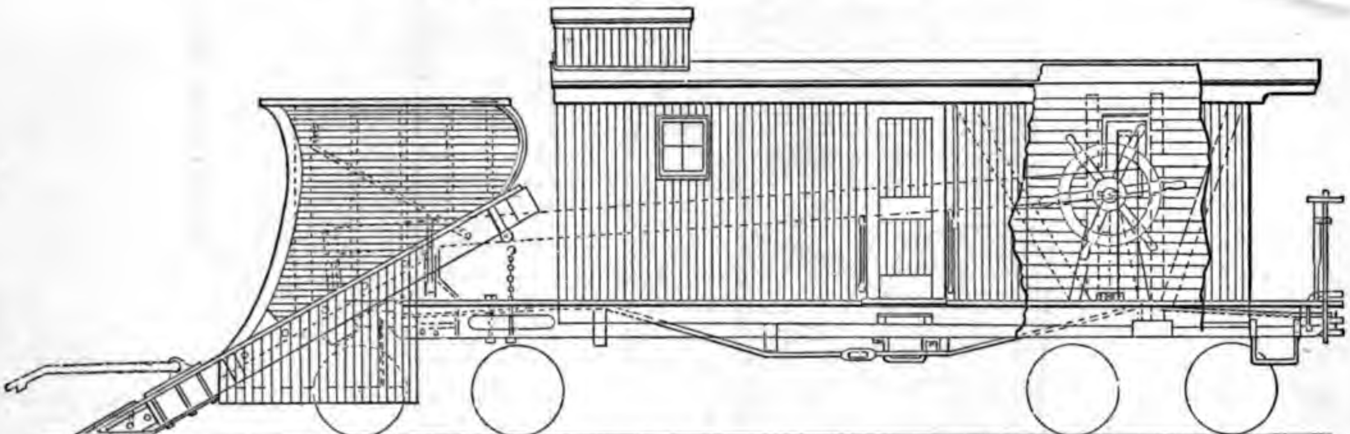


Scale ¾ inch to foot.

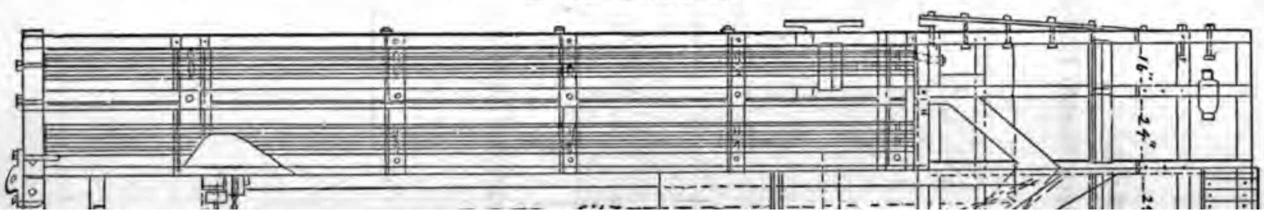
S. M. Keeler, Master Mechanic.

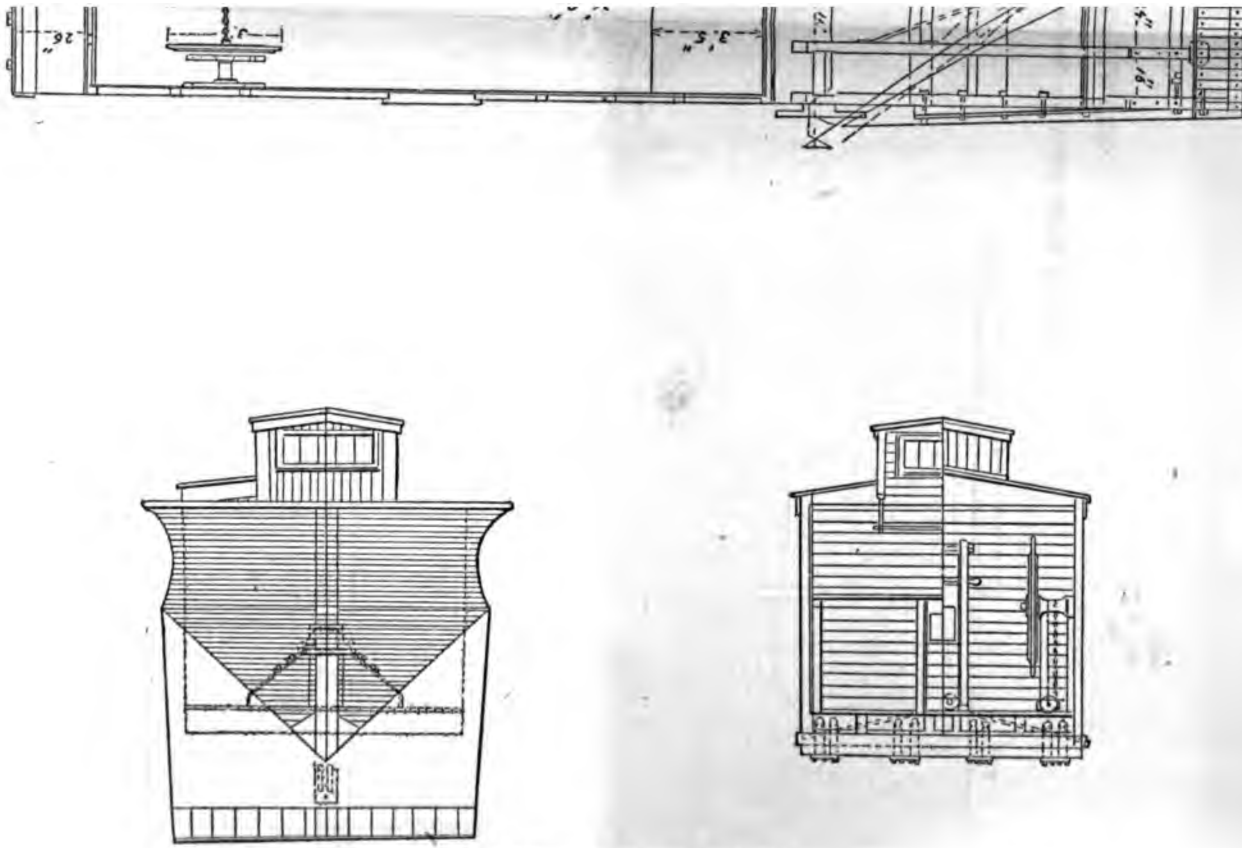
DRAWING No. 4.

Snow Plow Used on Northern Pacific Railway.



Length of car body 28 feet.

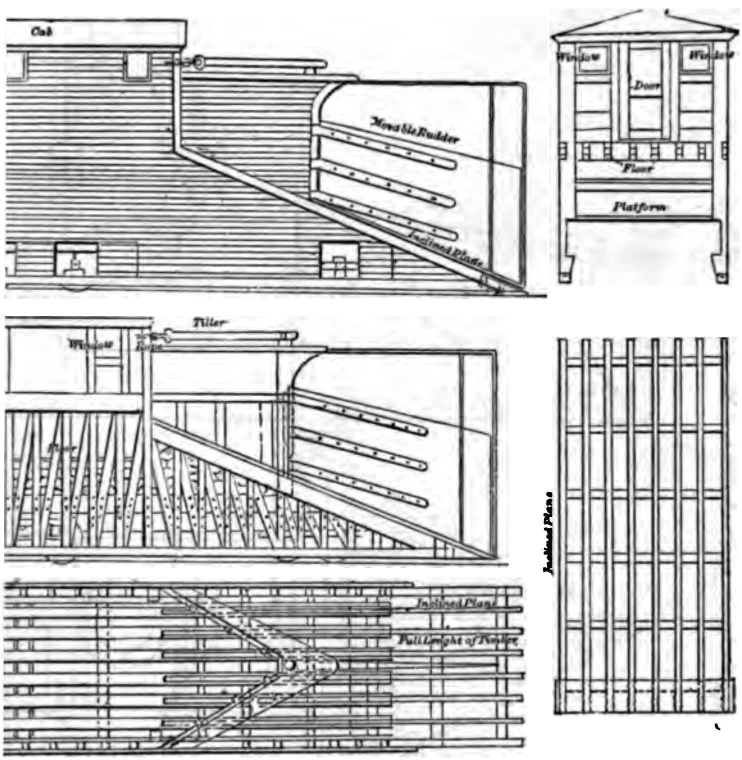




G. W. Cushing, Master Mechanic.

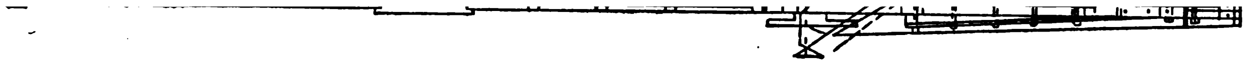
DRAWING No. 5.

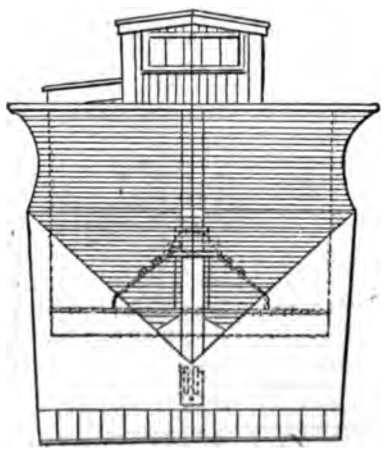
Snow Plow Used on Kansas Pacific Railroad.

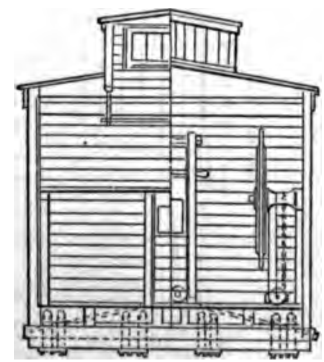


o 1 foot.

L. H. Waugh, Master Mechanic.



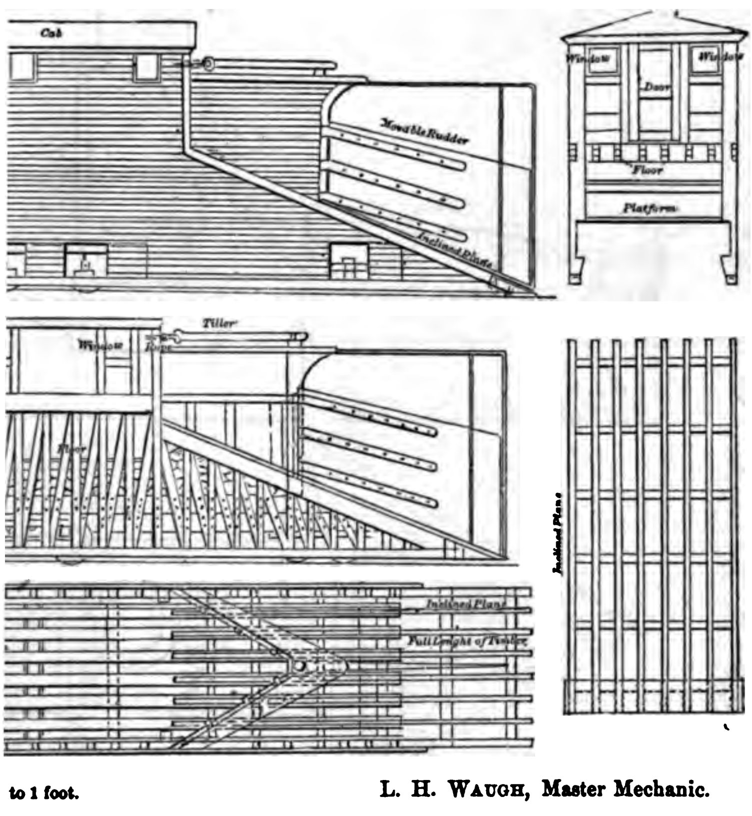




G. W. Cushing, Master Mechanic.

DRAWING No. 5.

Snow Plow Used on Kansas Pacific Railroad.

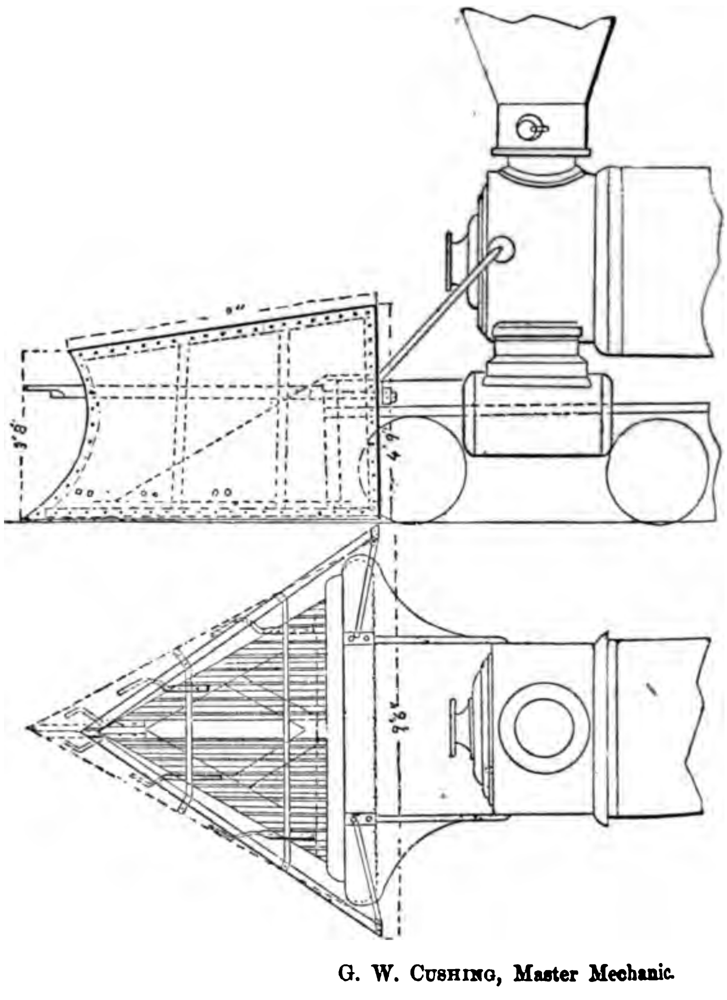


to 1 foot.

L. H. WAUGH, Master Mechanic.

DRAWING No. 6.

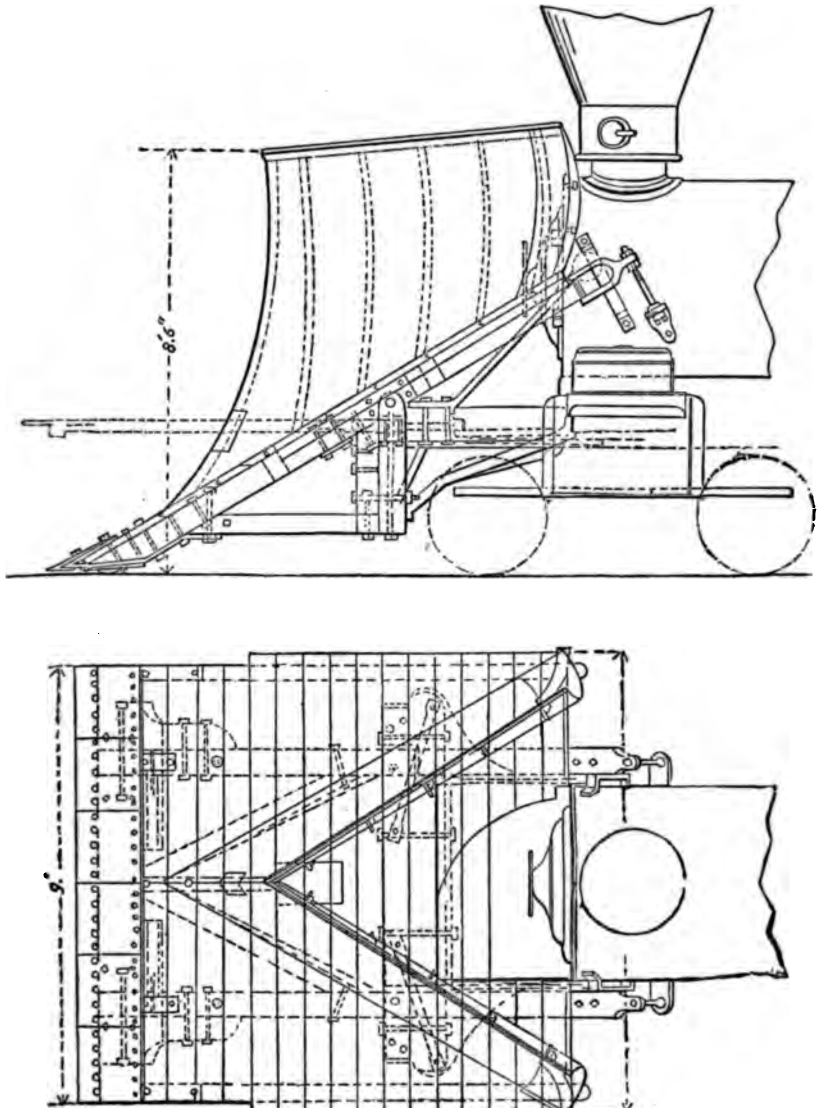
Snow Plow Used on Northern Pacific Railway.



G. W. CUSHING, Master Mechanic.

DRAWING No. 7.

Snow Plow used on Northern Pacific Railway.



GEORGE W. CUSHING Master Mechanic.

motives, also whether there is anything to be Gained by the use of Com-
d Axles and Loose Wheels," presented the following report:

ort of Committee to Investigate "The Best Form and oportions of Axles for Cars and Locomotives, also wheth- there is anything to be Gained by the use of Compound :les and Loose Wheels."

order to procure information regarding this subject, the Com- :e to whom it was submitted issued a circular containing the fol- ıg inquiries:

What are the dimensions of the standard car axles now used on your ? which please mark on the engraving below.

When such standard axles break, at what point does the fracture usually ?

State as near as you can what proportion of breakages of axles *of the ısions given* occur close to the hub of the wheel on the inside, and the ve proportion of breakages at other points?

If there were no car axles now in use, what size would you recommend ıe diameter and length of journal for a *universal standard axle* for four :ight and one-half inch gauge roads?

What for the diameter at the wheel seat and at the center of the axle?

What are the dimensions of the driving and truck axles of your most ›ved locomotives?

State where the fracture of such axles occur in cases of breakage?

What is your rule for forcing on car and locomotive wheels; that is much larger is the axle than the hole in the wheel? and how much is ıaximum pressure allowed in pressing them on?

Have you used any compound axles, or any axles upon which the wheels ›ose or can turn independently one of the other?

Have you any means of knowing, *experimentally*, the difference there is en the resistance of a car or truck with loose and one with tight wheels ısing around curves of any given radius; if so, give the Committee a t of such experiments?

What is your opinion of compound axles or loose wheels?

ı this circular the Committee received thirty-one replies, in some hich the subjects referred to in the inquirics were discussed at derable length. One of them, written by Mr. Wells, of the rsonville, Madison & Indianapolis Railroad, contains an account .periments which he made to illustrate the effect of loose and wheels on curves, and which it is thought has so much value

that they recommend that it be read and discussed independent of their report.

The substance of the replies to the first question of their circular —"*What are the dimensions of the standard car axles now used on your road?*—they have embodied in the table which is submitted herewith. Through the Secretary of the Master Car Builders' Association, the replies of the members of that society to a committee appointed to consider the same subject were placed at the disposal of your Committee. The list of standard axles is therefore more complete than it otherwise could have been made, and embraces those used on about eighty different roads. The great diversity which exists in the size of axles used indicates plainly the importance of taking some action to establish a standard size for universal use.

To the second inquiry, "*When such standard axles break, at what point does the fracture usually occur?*" nearly all answered that a very large majority of fractures occur just inside the hub of the wheel. Six members answered that they have had no breakages. One reports that "breakages are about equally divided between the center of the axle and the part close to the hub, on the inside, and the journal nearest to the wheel." Another member reports, "Our iron axle when it breaks does so close to the wheel, on the inside of hub. Steel axles formerly broke at the same point, but the axle was increased in size in the wheel-fit from four and one-quarter to four and three-quarter inches diameter, and since then we have had four to break in the journal at the end nearest the wheel. From late experience I believe that the number of breakages of *steel* axles in journal and next the hub of wheel is about equal." A number of the replies contain very decided condemnation of the use of sharp corners, and assert that their use is a very prolific cause of fracture.

In reply to the fourth and fifth inquiries, "*If there were no car axles now in use, what size would you recommend for the length and diameter of journal, and diameter of wheel seat and at center, for a universal standard axle for four feet eight and one-half inch gauge roads?*" eight members recommended $3\frac{1}{4}$ inches for the diameter of journal; one, $3\frac{3}{8}$; fourteen, $3\frac{1}{2}$; one, $3\frac{5}{8}$; and two, $3\frac{3}{4}$ inches. For the length of journal, one recommended $5\frac{1}{2}$ inches; fourteen, 6; two, $6\frac{1}{2}$; and nine, 7 inches. For the diameter of wheel seat, three recom-

nended $4\frac{1}{8}$; one, $4\frac{3}{16}$; eleven, $4\frac{1}{4}$; one, $4\frac{5}{16}$; three, $4\frac{3}{8}$; one, $4\frac{7}{16}$; our, $4\frac{1}{2}$, and two, $4\frac{5}{8}$. A similar diversity of opinion exists regard-ng the size for the center of the axle. These figures are given in a abular form herewith.

Diameter of Journal.	Length of Journal.	Diam. of Wheel Hub.	Diam. at cen. of Axle.
$3\frac{1}{4}$ inches.	6 inches.	$4\frac{1}{8}$ inches.	$3\frac{5}{8}$ inches.
$3\frac{1}{4}$ "	6 "	$4\frac{1}{4}$ "	$3\frac{3}{4}$ "
$3\frac{1}{4}$ "	6 "	$4\frac{1}{2}$ "	4 "
$3\frac{1}{4}$ "	6 "	$4\frac{1}{4}$ "	$3\frac{1}{2}$ "
$3\frac{1}{4}$ "	6 "	$4\frac{1}{4}$ "	$3\frac{3}{4}$ "
$3\frac{1}{4}$ "	$6\frac{1}{2}$ "	$4\frac{1}{4}$ "	$3\frac{1}{2}$ "
$3\frac{1}{4}$ "	7 "	$4\frac{3}{16}$ "	$3\frac{7}{8}$ "
$3\frac{1}{4}$ "	6 "	$4\frac{1}{4}$ "	$3\frac{7}{8}$ "
$3\frac{3}{8}$ "	$5\frac{1}{2}$ "	$4\frac{3}{8}$ "	$3\frac{3}{4}$ "
$3\frac{1}{2}$ "	6 "	$4\frac{1}{4}$ "	$3\frac{3}{4}$ "
$3\frac{1}{2}$ "	6 "	$4\frac{3}{8}$ "	$3\frac{7}{8}$ "
$3\frac{1}{2}$ "	6 "	$4\frac{1}{4}$ "	$3\frac{3}{4}$ "
$3\frac{1}{2}$ "	6 "	$4\frac{5}{8}$ "	4 "
$3\frac{1}{2}$ "	6 "	$4\frac{1}{4}$ "	$3\frac{3}{4}$ "
$3\frac{1}{2}$ "	6 "	$4\frac{1}{8}$ "	$3\frac{3}{4}$ "
$3\frac{1}{2}$ "	6 "	$4\frac{1}{2}$ "	$4\frac{1}{4}$ "
$3\frac{1}{2}$ "	$6\frac{1}{2}$ "	$4\frac{5}{16}$ "	$3\frac{1}{2}$ "
$3\frac{1}{2}$ "	7 "	$4\frac{1}{4}$ "	4 "
$3\frac{1}{2}$ "	7 "	$4\frac{1}{2}$ "	$3\frac{7}{8}$ "
$3\frac{1}{2}$ "	7 "	$4\frac{1}{4}$ "	$3\frac{3}{4}$ "
$3\frac{1}{2}$ "	7 "	$4\frac{1}{2}$ "	4 "
$3\frac{1}{2}$ "	7 "	$4\frac{1}{8}$ "	$3\frac{3}{4}$ "
$3\frac{1}{2}$ "	7 "	$4\frac{3}{8}$ "	$3\frac{3}{16}$ "
$3\frac{5}{8}$ "	7 "	$4\frac{7}{16}$ "	$3\frac{7}{8}$ "
$3\frac{3}{4}$ "	7 "	$4\frac{1}{4}$ "	4 "
$3\frac{3}{4}$ "	7 "	$4\frac{5}{8}$ "	4 "

The part of the axle subject to the most wear is of course the ournal. With considerable uniformity in the weight imposed upon ne journals, we find nevertheless great want of uniformity in the imensions of these parts. This seems the more surprising when we onsider that very reliable experiments have demonstrated the advan-age of some increase in the amount of wearing surface, over what as in early railroading deemed good practice. Take, for example, he experience of the Reading Railroad. In 1867, Mr. James Mill-olland, then residing at Mount Savage, Maryland, wrote to a mem-

ber of this Committee on this subject, from which letter we extract the following:

"MOUNT SAVAGE, Md., *27th April*, 1867.

"MY DEAR SIR: I have your favor of the 19th inst. Absence from home prevented me from answering until the present time. As to the advantages of long journal bearings over short ones, for any purpose, there is no doubt. Not my opinion, but my experience, has clearly demonstrated that fact.

"The Philadelphia & Reading Railroad Company furnishes an express company an eight-wheel car, to run between Philadelphia and Elmira, N.Y. When the car was first put on the route, the journals were five and a half inches long and three inches diameter, with a soft-metal bearing, with a strip of brass about an inch wide in it, which rested on the top of the journal. I found that the journals of the axles wore out before the wheels—in fact, they did not last much over one year, and were a constant annoyance from heating. To remedy this defect I put axles under the car, with eight-inch journals in length and three and a quarter inches diameter, and I never knew an instance of their heating. After the car had been run about one year with the long journals, I had one of the bearings removed (it was made in precisely the same manner as the short one) to examine it and the journal, and could see no perceptible wear in either of them."

We do not know of any extended experiments in this country to determine the best proportion of length and diameter of journal under the pressure of a given load. On marine engines, journals have been worked under a pressure of five hundred pounds to the square inch, but with unusual precautions to insure proper lubrication, and an abundant radiating surface to dispose of the heat generated by friction. Car axle journals are in many instances subject to a pressure of three hundred and eighty pounds to the square inch, with only an indifferent condition of lubrication and cleanliness or freedom from grit. Friction, within the limit of safety from abrasion, is totally irrespective of surface. Increase of wearing surface neither increases nor diminishes friction. Increase of diameter of journal diminishes the ejective leverage, and under the same conditions acts as a greater retardent to motion, not because the friction is increased, but the retardation from friction occurs at a greater distance from the center of the axle, and under conditions of greater velocity. This being the case, increase of length of journal is of more advantage than increase of diameter, all other things being equal. In-

ase of length can only be within the limits of strength of the tal forming the axle. Mr. Millholland's experiment shows that a rnal eight inches long is admissable; one seven inches long by ee and a quarter inches in diameter, which is still more than twice diameter in length of bearing, is clearly practicable, and your nmittee believe this proportion has been adopted by the Pennsyl- ia Central and a few other roads. The questions to be decided careful experiment are on the case of car axles: 1. The greatest ssure per square inch that it is safe to carry with the ordinary thods of lubrication; 2. The limit of elongation of bearing on overhanging journal to any given diameter within limits of safety. is not a difficult matter to give the sizes of a theoretically well- portioned journal for this purpose, adapted to any given condition weight, character of the journal bearing, and the nature of the ricant; but your Committee are not well enough satisfied as to average of these conditions in practice, and deem it advisable to ke further inquiries in this direction, yet feel satisfied that an in- se of length over five and a half inches will be found to be in direction of economy.

he replies to the sixth and seventh inquiries, regarding the di- sions of the most approved engine and engine truck axles are odied in the following table :

ROAD.	DRIVING AXLE.					TRUCK AXLE.				
	Diameter of Journal.	Length of Journal.	Diameter of Wheel seat.	Length of Wheel seat.	Diameter in center.	Diameter of Journal.	Length of Journal.	Diameter of Wheel seat.	Length of Wheel seat.	Diameter in center.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
Jeffersonville, Madison & Ind'apolis	6½	7⅛	6½	7	6½	4⅝	8	4⅝	6¼	3 11/16
Eastern	7	7½	6¾	.....	6½	4½	7	.....	.....	4
Terre Haute & Indianapolis	6½	8	6¼	7	6½	4½	8	4⅝	7	4
Panama	6	6¾	6⅝	6⅜	5½	4	6⅛	4	7⅛	3¾
Maine Central	7	.....	.....	.....	.....	4½				
Flint & Pere Marquette	7	8	.....	.....	.....	4½	7			
Raleigh & Gaston	6½	.....	6¼	.....	.....	4½	.....	4		
Kansas Pacific	6½	.....	.....	.....	.....	4½				
Central, of New Jersey	6½	8	.....	.....	.....	4½	7½			
Cleveland & Pittsburgh	6⅝	.....	6¼	.....	.....	4⅜	.....	4 3/16		
Eastern Kentucky	6½	7	6¼	6⅜	6¼	4½	7	4¾	6½	4¾
N. Y. & Oswego Midland	.....	.....	.....	.....	.....	4½	8	4¼	7	4
Grand Trunk	6½	7¾	7	.....	6½					
Lackawana & Bloomsburg	6½	.....	6½	.....	.....	4½				
Great Western, of Canada	7	7½	7⅛	7	6½	4½	8	4½	7	4
Buffalo, Corry & Pittsburgh	6½	7¼	6¼	7½	.....	4⅝		4¼	.....	4
N. Y., Boston & Montreal	6	8	6½							
Midland Pacific	6½	.....	.....	.....	.....	4½				
Charlotte, Columbia & Augusta	6½	.....	.....	.....	.....	4½				
Old Colony	6½	7	.....	.....	.....	4½	8	4⅝	.....	4
Cleveland, Col., Cin. & Indianapolis	6⅝	.....	.....	.....	.....	4¼				
Connecticut & Passumpsic River	6½	7½	6½	.....	6½	4½	7½	.....	.....	3¾
Hannibal & St. Joseph	7	7½	7	.....	7	5	9	4¾	7	4¼
Pittsburgh, Ft. Wayne & Chicago	6½	7⅜	6⅜	7½	6⅝					

To the seventh inquiry asking when the fracture of such axles occurs in cases of breakage, ten members have replied that they have had no breakages of such axles; an equal number report that the breakages occur almost invariably next to the hub of the wheel.

With reference to the subject of the eighth inquiry, "*What is your rule for forcing on car and locomotive wheels; that is, how much larger is the axle than the hole in the wheel? and, how much is the maximum pressure allowed in pressing them on?*" the opinions of the members seemed to differ very widely. Some report that they make axles and wheels as nearly of one size as possible, while others allow a difference of as much as $\frac{1}{64}$ for car and $\frac{1}{32}$ for engine wheels; some

n the axles straight, while others make them tapered; some make ;ine axles straight and car axles tapered, and others reverse this .ctice. One member reports, "I have no particular rule for cing on car wheels. I find it don't work. Some make of wheels much tougher than others."

With reference to the pressure employed there is a diversity of ıctice, and it varies all the way from fourteen to forty-five tons car wheels and from twenty-eight to one hundred tons for engine eels. One member reports that he "fits them as tight as his old ew press will put them on." It will thus be seen that the replies m members shed very little light on this very important subject. e are enabled to give the practice that obtains with the firm of A. hitney & Sons and has proven satisfactory in their experience. It believed that Mr. Asa Whitney was one of the first in this country o endeavored to introduce a practical system of uniform sizes and in car wheels and their axles. His earliest practice, now quite ıerally recognized, was to bore the wheels with double-ended ;ters, one cutter taking out the mass of the metal to be removed, ng a fine feed bit to finish by taking a very light cut and a rapid or ırse feed, say ⅜ inch to the revolutions of the wheel, thus hurry- ; the cutter through with as little chance to wear as possible. us, to insure uniformity of size in eye, this firm make the cutters t in the center and capable of being kept up to size by stretching h hammer and anvil. They use a screw press for forcing on, to ich was afterward adapted a hydraulic cylinder for the purpose noting the pressure, and they now endeavor to insure a uniform ssure of about thirty tons. Their practice in turning the fit part axle is to (rough it) turn with a tool that leaves a decided feed rk on the axle. A finishing tool is run on to this surface to in- e easy entering of the axle into the wheel; but the fit size, .007 h larger than hole, is obtained not in the lathe but in a separate chine by running over this surface a hollow reamer in which the merous cutting edges are from time to time adjusted to size is effect is to remove the responsibility of the fit from the skill. the workman and to enable less skillful workman to produce more d better work than if unaided by these labor-saving devices. ıe question of relative size of axle and eye was carefully con-

sidered in England, and the published results of the experiments agree nearly with the practice as given above, and which your Committee think is in reality the common practice of this country. Doubtless very hard wheels require less difference of size than softer wheels, but in an extended system of manufacturing some practical uniform rule must of necessity be adopted; and your Committee are of opinion that for car axles and for driving axles a difference of size of .007 of an inch (.012 for the other) is sufficient, and will in practice require thirty tons pressure to force on car wheels and a proportionate amount for driving wheels.

To the eighth and ninth inquiries regarding loose wheels and compound axles, nearly all the members who answered the Committee's Circular report that they have had no experience with loose wheels. Mr. W. H. Griggs, of the New York & Oswego Midland road, reports that he has used "Gardner's Patent Cast Sleeve in center of axle," and that he "placed two cars, one with the patent axle the other a similar car with an ordinary truck, on a fifty foot grade and a five degree curve, and started them each from the same point. The car with the patent axle ran two hundred and eighty feet the farthest, and also ran very smoothly around curves." Mr. Thomas Connell, of the Buffalo, Corry & Pittsburgh Railroad, reports that he "had some experience with each wheel of a truck on an independent axle, but it did not work well. There were several thousand dollars expended on it, after which it was thrown away. It amounted to nothing but expense while it was in use." Another member is of the opinion that "if one loose wheel were used it would result in great saving in wear and tear." With this latter exception all who have made any reply to the eleventh inquiry are very decided in their condemnation of all loose wheels and compound axles.

Were it not that there is now and has been for many years a perennial crop of inventions of different forms of loose wheels and compound axles the subject would, perhaps, not require any further consideration, but as much time, money, patience, and ingenuity has been wasted in this direction, the Committee have thought that a resolution expressing it as the opinion of this Association that the use

would not result in any advantage might do some
ng the attention of over-sanguine inventors into more
s. They also suggest that the discussion of this part
be postponed until after Mr. Wells' paper is read, to
has already been made.

of your Committee engaged in an extensive series of
icted experiments about twenty-two years ago to
e disadvantage of tight wheels, but these experiments
same conclusions as were obtained by Mr. Wells in
it experiments, in which it will be noted he found
e in the use of loose wheels at slow speed, but a dis-
e speed which obtains in ordinary traffic.

ittee are of opinion that it is very desirable that some
rd of axle be adopted by this Association which in
to be the standard of the land, but in view of other
at this time engaged on this same subject and having
mmon, your Committee beg leave to report progress
k the passage of the following resolutions:

hat this Committee be continued, and that it be authorized
e Committee appointed by the Master Car Builders' Associa-
purpose, to report at the next meeting.

hat in the opinion of this Association no practical advan-
from the use of loose wheels or compound axles in ordinary

All of which is respectfully submitted,

M. N. FORNEY,
COLEMAN SELLERS,
GARTEN H. NOTT,
} *Committee.*

e report was accepted.

, Jeffersonville, Madison & Indianapolis Railroad, read the
which was received and ordered to be printed with the
mmittee:

A Paper Read by Mr. Wells, of the Jeffersonville, M Indianapolis Railroad.

JEFFERSONVILLE, IND., April

M. N. FORNEY, ESQ., *Chairman of Committee on Axles:*

DEAR SIR—In reply to your Circular you will find questions:

1. Sizes of our Standard Axles for Cars, given in sketch back of your Circular inclosed.

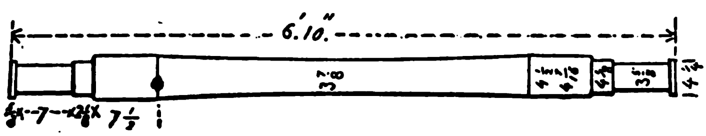
2. We have never had one of our standard axles break.

3. I think that seven-eighths of all the car and tender axles have ever seen that broke while in use broke at the shoul inside of the hub of the wheel, and in all cases, so far as ber, such axles were badly proportioned at that point—to difference between the diameter in the wheel and that of immediately inside of the hub, in other words had too shoulder. A shoulder on an axle at the point referred effect "*the beginning of a crack.*" When the strain upon that point never exceeds the elastic limit of the iron results, at least for a long time, but whenever that limit is injury follows and an *actual crack* then commences, al slight that it could not be detected at first by any means of tion in use, yet the cause that produced the beginning, how that might be, is repeated occasionally by the *unusual* strain upon the axle in running over rough track or bad frogs, ings that lay solid and are like large anvils, until the *beginning* of a crack at last assumes larger proportions, and only a question of *time in use* as to when the break will there was no shoulder on the axle at that point then the "*of the crack* in effect" would not be there. It is not p perhaps, to dispense entirely with a shoulder on axles ins wheels on account of reducing the diameter in turning seat. To turn the axle inside of the wheel seat to the

onal inch of axle at *all points in its length the same strain* (work to o). More strain upon one point in the axle than in any other, ı proportion to the strength of iron to bear it, would be more ϵpensive than to increase the size of the axles to a point of safety ven with a slight shoulder.

Good material—a sufficiency of it—and in just the proportion required to do the work of each part in the length, and the smallest shoulder practicable inside the wheels, is the best preventative that I know of against axles breaking—ESPECIALLY AVOID SHOULDERS *inside of the wheels*. The axle question, in my opinion, has not yet generally received the attention from railroad men as a class that is due the importance of the subject. I have seen but few axles that were broken at any other point than just inside the wheels, such as did break elsewhere broke on account of large defects in the iron from not welding in the manufacture.

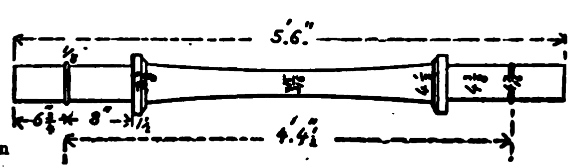
4. Would recommend the following as a universal standard for an iron axle for passenger and sleeping cars of usual size on a 4 feet $8\frac{1}{2}$ inch gauge road:



For freight cars, or light passenger or baggage cars, would recommend axles of above lengths in all points, but a reduction in diameter as follows: journal $3\frac{1}{2}$ inches, wheel seat $4\frac{5}{8}$ inches, inside of wheel seat $4\frac{7}{16}$ inches, center $3\frac{15}{16}$ inches.

The above also answers question five.

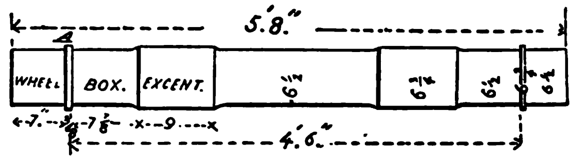
6. Dimensions of standard engine truck axles on this road are as follows:



Collars shrunk on

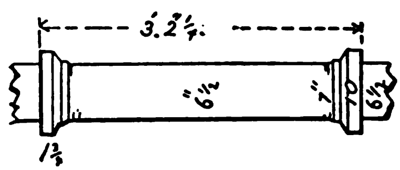
The dimensions of driving axles for locomotives of 16×24 inch cylinders are as follows:

FORWARD AXLE.



A A are small collars that fit into hubs of wheels large enough prevent the wheels from working inward, if they should ever g loose.

CENTER OF BACK AXLE.



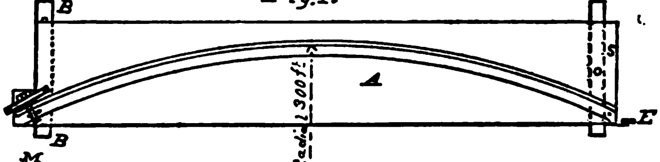
7. Never had one to break.

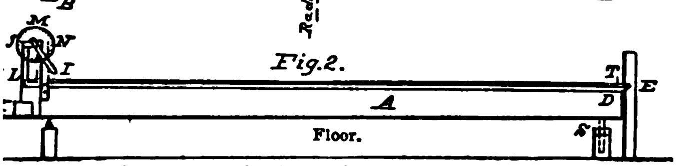
8. Have been unable to fix a rule for forcing on wheels. A difference in size of the hole in the wheel and the diameter of owing to the difference in quality or *hardness* in the metal of hubs of the wheels, the softer the metal in the hub the gre the difference in diameter must be to have wheels go on at e pressures. This is particularly the case with driving wheels. old driving wheel rebored, or put on a new axle without rebo will not give or stretch as much as a new one, sometimes by one as much. Having been once forced on and strained in use the seems to become more compact and will not stretch so easily new casting, and consequently, sizes being equal, will make a tighter fit than a new wheel, in fact in many cases will not go all at proportions used for new wheels. There is also a differen new wheels when made from different qualities of iron. A wheel will make a loose fit, where one of hard iron of same would be very tight. This rule holds good with car wheels so that the *rule* must be changed somewhat with the quality of iron composing the hubs of the wheels to be put on. Maxi pressure allowed in putting on wheels is for car wheels 40 (80,000 pounds), truck wheels 45 tons, driving wheels 80 Minimum pressure for car wheels 25 tons (50,000 pounds), t wheels 35 tons, driving wheels 50 tons.

I have not.

In reply to the tenth question of your circular, I will state I made a series of experiments with the view of determining ıdvantages to be derived, if any, in *hauling* power by the use of ›ound axles or "loose wheels" over those where the wheels are t on the axles while passing curves in the track, also the differ- in hauling power *due to the gauge of the track*, other things g equal. For this purpose I constructed the model of a track freight car truck one-sixteenth of actual size. The track rep-nted a curve of three hundred feet radius, and a gauge of 4 feet nches. A third rail laid between the other two represented a et gauge, measuring from the inside rail of the 4 feet 8½ inch k. The rails were of iron and planed perfectly straight and ›oth on top, the tops representing a width of 2½ inches, and were ved as nearly perfect as was practicable and laid on a platform as resented in the sketch and marked *A A*. The track on the plat-

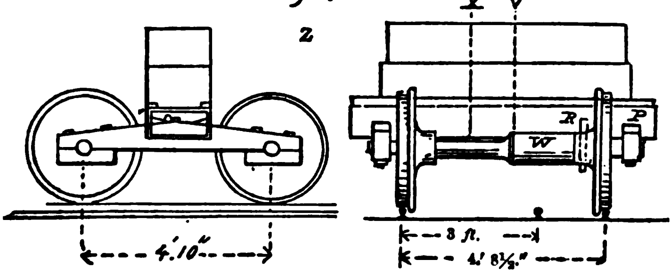
Fig.1.





Scale ⅜ inches=1 foot in model.

Fig 3.



Scale ⅓ full size of model.

form represented a length of 273 feet, measuring along the curve. One end of this platform rested upon stationary bearings *B B*, while the other end was supported upon a screw *S*, so that it could be elevated at that end to any point desired above the level, thus placing the track on an incline or grade, the pointer attached to the platform at *D*, and the graduated post *E*, giving the incline of the track. At the end of the track at *H*, and immediately over it was attached a frame having a cross shaft at the top with an arm *I* extending down toward the center of the track, and another arm extending toward *J*, to the end of which the weight *K* was attached by the rod *L*. To this frame was attached a graduated dial with a registering hand *M* moved by a pin on the shaft.

The object of this arrangement was to determine the force or momentum of a truck running down the inclined track when arriving at and striking the arm *I*. By moving the arm *I* toward *H*, the weight *K* would be raised from its resting place, and the registering hand *M* at the same time be moved toward *N*, and when the force required to move the arm *I* is overcome or expended, the weight *K* will drop to its resting place again and arm *I* return to its original position. By adding to or diminishing the weight *K*, an accurate registry was made suiting the force of the truck, striking the arm *I* at either a very low or a high speed, and as a means of comparison between the different trials for speeds within reasonable limits was perfect.

A truck (Fig. 3) was made, the wheels of which were of brass, turned perfectly true, and representing a diameter of 33 inches, the axles were of iron and represented a length of 6 feet 9 inches, the journals $3\frac{1}{2}\times 7$ inches, spread of axles of 4 feet 10 inches. The beam holding the journals on one side of the truck was made tight and solid to the bolster *P*, while the beam on the other side rested upon a point in the center of the bolster at *O*, allowing the ends of the beam a vertical movement independent of the opposite beam and thus bringing an equal load on the wheels under all circumstances. The wheels on one end of the axles were tight—the wheel and axle turning together—while those on the other were loose, turning freely and truly on the axles. When the pins through the hubs of the wheels and axles at *R* were removed, so that the truck could be

changed from wheels tight on the axles, to one with loose or independent wheels, without any other change whatever other than removing the pins through the hubs and axles, the hubs of the loose wheels represented a length of bearing on the axles of thirteen inches, and a bore of four inches, and were so turned on the face that the friction of the hub and collars on the axles when turning as loose wheels was reduced to the lowest point practicable. On the end of the axles next to the loose wheels was a sleeve *W*, on removing which the wheels could be adjusted to suit the gauge of track representing three feet, the sleeve *W* being placed on the axle between the outside of the wheel and the box; the axles having holes for the pins at the point corresponding to the three foot gauge also, and the wheels at that gauge could be made either tight or loose as desired. The load on the truck consisted of lead and cast iron, and was arranged so that the center of gravity—including the truck—for each gauge of track always corresponded with the center of the track upon which the truck was placed; for instance, in changing from the wide to the narrow gauge, the center of gravity of the truck and load was changed from *V* to *X*, by moving the load toward *Z*, thus keeping the weight on all the wheels and on both rails equal; the weight on the *journals* however would be unequal, for the narrow gauge being increased on one side of the truck and correspondingly decreased on the other, the *average* remaining the same, and the *average* of the journal friction also remaining the same as for the wide gauge. Every working part of the truck, and the surface, curve, and guage of the track was made as near perfect as possible the object being to make as fair and impartial a series of trials as possible, to determine the difference in hauling power of a truck and load in a curve of three hundred feet radius, due to the condition of the wheels on the axles, and also due to the gauge of the track.

The force of gravity alone was made use of for propelling power. The platform *A* being raised by the screw *S* at *E* to the incline, requisite to overcome the rolling and other friction due the truck in passing the curve, the truck if placed at *E* and let go will run down the incline, striking the arm *I*, and be stopped by the operation of the weight *K*, which, when adjusted to suit the force of the truck,

will be raised from its resting place, the arm *I* going toward *L*. The truck being stopped, is pushed back by the arm *I* assuming its original position, the dial hand registering the position to which the arm *I* had been driven, and the weight *K* raised by the momentum of the truck when arriving at the foot of the inclined curve.

A number of trials were first made to see that everything worked perfectly, and it was found that a difference in the incline of one in five thousand nine hundred and eighty (5,980) could always be detected in the speed of the truck and effect on the registering hand of the dial, at speeds below that corresponding to twelve miles per hour, showing that the whole arrangement was extremely sensitive. Tests were made to see if any difference could be detected in the results as to whether the loose wheels were run on the outside or the inside rail of the curve; but finding none, the truck was run in all the trials given below, with the loose wheels on the outer rail. The wheels were coned corresponding with that of new car wheels in general use, represented a diameter of thirty-three inches, and had a lateral play corresponding to one and a quarter ($1\frac{1}{4}$) inches on the rails on both gauges. Estimating by *measurement*, the truck and load represented a weight of nine and a half ($9\frac{1}{2}$) tons of two thousand pounds. The figures given in the trials are made up from ten or more trials of each kind and averaged, then reported as one. Before making the series of trials the loose wheels were taken off, and the hubs and axles cleaned of all gum or thick oil that might in the least interfere with their working as loose wheels; and in making the "runs" the truck was drawn up to a pin fastened between the rails at *T*, Fig. 2, care being taken that the flanges of the wheels were always in the same relative position to the rails at each trial, and the truck at each run starting itself from the pin and running down the incline from the force of gravity, being stopped by the arm *I* at the dial.

[T]he following tables give the average results of ten or more trials each:

[We]ight of Truck representing 9½ Tons; Radius of Curve, 300 *Feet; Gauge of Track representing* 4 *feet* 8½ *inches.*

Incline of Track. (Grade.)	Speed per hour...	Condition of Wheels on the Axles.	Running Time...	Dial Hand.........
1 in 52.36	8.64 miles.	Loose on both axles......................	19 sec.	3½ deg.
1 in 45.71	8.64 "	Tight on both axles......................	19 "	3½ "
1 in 52.36	10.21 miles.	Loose on both axles......................	16 sec.	9 deg.
1 in 52.84	10.21 "	Tight on forward axle, loose on back axle..................................	16 "	9 "
1 in 45.00	10.21 miles.	Loose on forward axle, tight on back axle..................................	16 sec.	8 deg.
1 in 46.45	10.21 "	Tight on both axles......................	16 "	8 "

[F]rom the above trials 1 and 2 it will be seen that the difference [in f]avor of loose wheels over those being tight on the axles—load, [spe]ed, and momentum of the truck at the registering dial at the [low]er end of the track, being precisely the same in both cases—is [repr]esented by an incline of 1 in 360; or, in other words, a truck [tha]t will run down the track when inclined 1 in 52.36, the wheels [bein]g *loose* on the axles, requires an *additional* incline of 1 in 360, [or a]n incline of 1 in 45.71 to cause it to run down *at the same speed* [and] *produce the same effect* in moving the hand on the dial when the [whe]els are *tight* on the axles, showing a slight advantage in favor of [loos]e wheels.

[T]he results of trials 3 and 4 show that when the wheels on the *[forw]ard* axle of the truck are *tight*, and those on the back axle are [loos]e, the truck will run down an incline of 1 in 52.84 in the same [tim]e, and produce the same effect on the dial hand as on an incline [of 1] in 52.36 when the wheels are loose on *both* axles, showing a dif[fere]nce in favor of wheels being tight on the *forward* and loose on

the *back* axle, represented by an incline of 1 in 57.60 over that where the wheels were loose on *both* axles; showing that no advantage can be claimed for loose wheels *on the forward axle of the truck*, but rather a disadvantage. It would seem singular at first that less power is required to draw a truck with a given load and at a given speed, on a curve, when the wheels on the *forward* axle are *tight*, and on the back axle *loose*, than when the wheels are loose on *both* axles. Yet all the subsequent trials made show this principle to be correct—*that no advantage is to be gained from loose wheels on the forward axle.* The reason for this I trust I shall be able to explain in due time.

The results of trials 5 and 6 confirm that of trials 3 and 4, showing conclusively that no advantage is to be derived from loose wheels on the *forward* axle. In trial 6, wheels tight on *both* axles, incline 1 in 46.45, the speed represented 10.21 miles per hour; effect on dial hand, 8 degrees. It was found that to produce the same speed and effect on the dial hand, when the wheels on the back axle were tight and on the forward axle loose, required an *additional* incline of 1 in 14.40, or an incline of 1 in 45 as against that where they were tight on *both* axles.

After increasing the load on the truck until it represented a weight of nineteen and one-half tons, the following trials were made and results obtained, which do not materially differ from previous ones:

Weight of Truck representing 19½ *Tons*; *Radius of Curve*, 300 *Feet*; *Gauge of Track representing* 4 *Feet* 8½ *Inches*.

No. of Trial......	Incline of Track. (Grade.)	Speed per Hour..	Condition of Wheels on the Axles.	Running Time...	Dial Point........
7	1 in 42.35	8.21 miles.	Tight on both axles...........	20 sec.	3½ deg.
8	1 in 49.65	8.21 "	Loose on both axles...........	20 "	3½ "
9	1 in 49.65	8.20 miles.	Loose on both axles......................	21 sec.	3 deg.
10	1 in 51.42	8.20 "	Tight on forward axle, loose on back axle......	21 "	3 "

Under the conditions presented above, the difference in favor of ›se wheels, in trials 7 and 8, is shown to be about 17 per cent.; d it is also shown that there is a slight advantage in having the ıeels tight on the forward axle, and loose on the back axle (trial '), over that where they are loose on both axles (trial 9).

The following trials were made in order to determine what effect e condition of the wheels on the axles had upon the speed, the cline of the track remaining the same for each series of four trials:

Truck representing 19½ *Tons, Radius of Curve* 300 *Feet.*

o. of Trial.	Incline of Track 1 in 36.90.	Speed per Hour.	Running Time
11	Wheels on forward axle tight, on back axle loose....................................	14.94 miles.	11 sec'ds.
12	Wheels on both axles loose..................	13.70 "	12 "
13	" " tight..................	9.67 "	17 "
14	" on forward axle loose, on back axle tight....................................	8.01 "	20½ "
	Incline of Track 1 in 32.72.		
5	Wheels on forward axle tight, on back axle loose....................................	18.46 miles.	8⅞ sec'ds.
6	Wheels on both axles loose..................	18.26 "	9 "
7	" " tight.	14.94 "	11 "
8	" on forward axle loose, on back axle tight....................................	14.29 "	11½ "
	Incline of Track 1 in 30.		
9	Wheels on forward axle tight, on back axle loose....................................	19.64 miles.	8⅜ sec'ds.
0	Wheels on both axles loose..................	19.33 "	8½ "
1	" " tight..................	15.12 "	10⅞ "
2	" on forward axle loose, on back axle tight....................................	14.94 "	11 "

Truck representing 9½ *Tons.*

No. of Trial.	Incline of Track 1 in 30.	Speed per Hour.
23	Wheels on forward axle tight, on back axle loose..	19.92 miles.
24	Wheels on both axles loose..................	19.33 "
25	" " tight	17.30 "
26	" on forward axle loose, on back axle tight......................................	16.43 "

From trials 11 to 26 inclusive, the difference in speed effected by the condition of the wheels on the axles. tions in effecting the speed confirm the conclusions dedu previous trials, showing the advantage of loose wheels i the lowest speeds, and to grow less as the speed is in also that the advantage comes from the *back wheels only* and that no advantage can be obtained from having th the forward axle, but rather the reverse.

The following series of trials were made to show that is increased the advantages to be derived from the wheels decreases:

Truck and Load representing 18,000 *Pounds, Radius of senting* 300 *Feet.*

No. of Trial......	Incline of Track. (Grade)	Speed per Hour..	Condition of Wheels on the Axles.
27	1 in 46.71	7.83 miles.	Forward tight, back loose............
28	1 in 45.60	7.83 "	Wheels on both axles *loose*..........
29	1 in 40.78	7.83 "	" " *tight*..........
30	1 in 38.61	7.83 "	Back tight, forward loose............

Truck and Load 38,000 *Pounds.*

Incline of Track. (Grade).........	Speed per Hour..	Condition of Wheels on the Axles.	Time Running...	Dial Point.........
1 in 45.25	7.83 miles.	Forward tight, back loose...........	21 secs.	10 deg.
1 in 43.54	7.83 "	Wheels on both axles *loose*....... ..	21 "	10 "
1 in 40.22	7.83 "	" " *tight*..........	21 "	10 "
1 in 39.67	7.83 "	Back tight, forward loose...........	21 "	10 "

Truck and Load 18,000 *Pounds.*

1 in 40.	12.65 miles.	Forward tight, back loose...........	13 secs.	Not used.
1 in 40.	12.55 "	Wheels on both axles *loose*..........	13¼ "	
1 in 40.	11.74 "	" " *tight*..........	13½ "	
1 in 40.	11.54 "	Back tight, forward loose............	14¼ "	

ck and Load representing 38,000 *Pounds, Radius of Curve representing* 300 *Feet.*

. of ial.	Incline of Track (Grade).	Speed per Hour.	Condition of Wheels on the Axles.
9	1 in 40.	12.65 miles.	Forward tight, back loose.
0	1 in 40.	12.18 "	Wheels on both axles *loose.*
1	1 in 40.	11.74 "	" " *tight.*
2	1 in 40.	12.18 "	Back tight, forward loose.
3	1 in 36.65	13.70 miles.	Forward tight, back loose.
4	1 in 36.20	13.70 "	Wheels on both axles *loose.*
5	1 in 35.32	13.70 "	" " *tight.*
3	1 in 35.20	13.70 "	Back tight, forward loose.

Truck and Load representing 18,000 *Pounds.*

No. of Trial.	Incline of Track (Grade).	Speed per Hour.	Condition of Wheels on the Axl
47	1 in 25.85	23.50 miles.	Forward tight, back loo
48	1 in 25.85	22.68 "	Wheels on both axles lo
49	1 in 25.85	22.68 "	" " ti
50	1 in 25.85	21.64 "	Back tight, forward loo

The curve when placed on an incline will not present a *unifo* incline in the line of the center of the track, yet, as the incline at no time above 1 in 25.85, and all the trials were made on same track, no material difference in the results would follow on t account. The truck always attained its maximum speed bef descending half the distance run. Every trial was *timed accurat* and the momentum of all the trials, at a speed representing less t twelve miles per hour, was registered on the dial. At speeds ab that the dial hand did not always register correctly, and TIME made use of in getting the results as to speed.

If we take the power developed by the *incline* and apply it drawing the same load in a curve of the same radius *on a level,* represented in that made use of in these trials, the result would as follows:

In trials 1 and 2 we find that the power developed, due t weight of truck and load, representing 19,000 pounds, descendi an incline of 1 in 52.36 should be 362.8 pounds, and that that absorbed in the rolling and other friction incident to a speed of 8. miles per hour in a curve representing a radius of three hund feet, the wheels being *loose* on *both* axles. Now, to produce same speed when the wheels were *tight* on both axles, it was necess to increase the inclination of the track from 1 in 52.36 to 1 in 45. The power developed on this incline should represent 415.6 poun which was absorbed in producing the same results as accompli by the power from the incline of 1 in 52.36 when the wheels w loose. The difference in the power developed, as above, would r resent 52.8 pounds, and that would represent the difference betw

the power required to draw that load in a curve of three hundred feet radius *on a level* when the wheels were *tight* on the axles, and doing the same when the wheels were *loose*, the speed in both cases being the same—8.64 miles per hour. The difference in *power* in this case being about 14½ per cent. in favor of loose wheels.

In trials 7 and 8, the truck representing a load of 39,000 pounds and speed 8.21 miles per hour, the difference in favor of loose wheels, as indicated by the difference of the inclination of the track, was a *power* of 135.4 pounds or about 17 per cent.

In trials 24 and 25, on an incline of 1 in 30, and with a load representing 19,000 pounds and a speed of 17.3 miles per hour, a difference in *speed* is shown of 11½ per cent. in favor of loose wheels over that where the wheels were tight on the axles, the *power* applied in both cases being the same.

If we take the *power* developed in trials 28 and 29, and apply it in propelling a truck and load representing 18,000 pounds, in a curve of three hundred feet radius and *level*, we find the following: The power due from a load of 18,000 pounds on an incline of 45.60 would represent 394.7 pounds, this being absorbed in friction in propelling the truck and load at an average speed of 7.83 miles per hour in a curve of three hundred feet radius, the wheels on both axles being *loose*. We find that to propel this truck and load when the wheels on both axles are *tight*, the other conditions being the same as above, requires an additional inclination of track sufficient to develop an additional power of 46.4 pounds in order to propel this load at the same speed, and produce the same results as when the wheels are loose on the axles; the difference in power required amounting to 11¾ per cent. This would represent the difference on a level track in producing and keeping up the same *speed* in both cases. Applying this rule to tests 32 and 33, with a load representing 38,000 pounds at a speed of 7.82 miles per hour and the same curve, we find the difference in *power* required in *producing the same results* to be but 8¼ per cent. in favor of loose wheels.

In tests 36 and 37, at a speed representing 11.74 miles per hour and load 18,000 pounds, the *power* being the same—the same incline—the difference in the result is 6⅞ per cent. in favor of loose wheels in the average *speed*.

Tests 40 and 41, at a speed representing 11.74 miles per hour and load of 38,000 pounds, the difference in favor of loose wheels is reduced to $3\frac{3}{4}$ per cent. in *speed*, the *power* (incline) being the same in both.

In tests 44 and 45, the speed representing 13.70 miles per hour and load 38,000 pounds, the difference in favor of loose wheels is but $2\frac{1}{2}$ per cent. in the *power* requisite to produce the same results in each case.

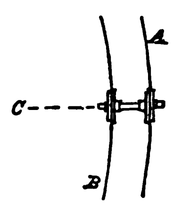
With a load representing 18,000 pounds, and at a speed of 22.68 miles per hour as shown in tests 48 and 49, no difference in speed could be detected in all the tests made in favor of loose wheels over wheels tight on the axles.

It will be noticed that all the tests made uniformly show that there is a slight advantage in having the wheels on the *forward* axle *tight* and on the back axle *loose*, over that when they are *loose on both axles*. By reference to the tests made with the wheels on the *forward* axle *loose* and on the *back* axle *tight*, they also uniformly indicate a slight advantage in favor of the wheels being *tight* on both axles. The advantages in point of hauling power in favor of loose wheels *decreases* as the speed is *increased*. Trials 28 and 29, at a speed representing 7.83 miles per hour, the difference in favor of loose wheels was $11\frac{3}{4}$ per cent. in the *power* expended in producing the same results. At a speed of 13.7 miles per hour—trials 44 and 45—the difference in favor of loose wheels was only $2\frac{1}{2}$ per cent. in *power*, while at a speed of 22.68 miles per hour—trials 48 and 49—no difference at all could be detected in *speed*, the power (incline) in both cases being the same.

It is shown that no advantage can result from loose wheels on the *forward* axle, but a disadvantage. The advantage, when there is any, as at low speeds and in short curves, is gained from the wheels on *back* axle being loose. The tendency of the back axle, when the wheels on it are *tight*, is to cause the forward end of the truck to swing or "crowd" outwardly in relation to the curve of the rails, thus producing friction on the collars of the forward axle and in the boxes. When the wheels on the back axle are *loose* this tendency to throw the forward end of the truck toward the outside of the curve

›es not exist, hence the difference in favor of the back wheels ›ing loose.

It is evident that there is less crowding of the flanges of the ›rward wheels against the rails when they are *tight* on the axle ıan when *loose*. The tests show that less power is absorbed in ‘iction when the wheels on *forward axle are tight* and back wheels ›ose than when wheels on *both* axles are loose. Owing to difference etween the length of the outer rail of the curve and the inner one, he wheels when tight on the axles must necessarily slip on one or oth rails to correspond with the difference in the length of the two ails. In experiments made it was found that one wheel gained bout as much as the other lost in the revolutions, due to the length f track run on by each, and to this slip—gain and loss—of the heels on the rails in passing a curve is to be attributed the fact hat the flanges of the wheels crowd the rails on the outside of a urve less when tight on the axles than when loose. The following rill serve to illustrate:

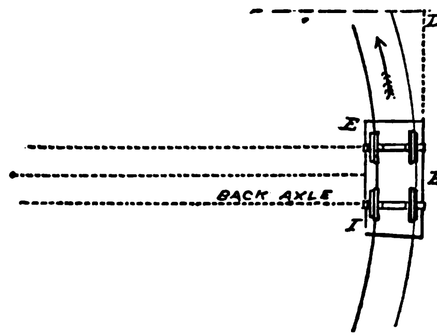


In passing the curve the outer wheel slides on the rail toward *A*, ’hile at the same time the inner wheel slides toward *B*. Now, when *oth wheels are sliding on the rails at the same time*, no additional ›rce is required to slide the wheels on both rails toward *C*, thus elieving the pressure of the flange of the outer wheel against the ail, beyond that requisite to overcome the tendency of all moving odies to go in a straight line, and to cause the load to move in a urve corresponding with the track. But when the wheels on the ›rward axle of the truck are independent, this *sliding* process, the uter one toward *A* and inner toward *B* in conforming to the curve f the track, does not take place, and the force necessary to *slide* the heels on the rails toward *C*, in conforming their movement to the

curve of the track, comes entirely from the pressure of the fla
of the outer wheel against the side of the rail, the inner wheel
this case having no *slip* on the rail toward B, as occurs when ti
on the axle. The *whole* force necessary to cause it to slide tow
C, in conforming to the curve, must come from the flange of
outer wheel bearing against the rail, and on this account the fricti
of the flange of the outer wheel against the rail is greater when
wheels are loose than when tight on the axle. Owing to the cen
lines of the axles being parallel with each other, and not coincidi
with radial lines from the center of the curve, the *tendency* of
truck, whether the wheels are tight or loose on the axles, is to run
a straight line, and the condition of the wheels on the axles d
not effect that in the least. The sliding of the outer wheel on
rail toward A, and the inner wheel toward B, when the wheels
tight on the axle, has no effect upon the hauling power required
passing a curve, except so far as the friction in the journal bo
and on the collars of the axles may be increased in keeping
axles of the truck parallel with each other. The tension broug
upon the axle by the one wheel gaining and the other losing wh
sliding on the rails, does not effect the force necessary to move
truck along the track. The tendency of one wheel to gain on
distance passed over exactly balancing the tendency of the ot
wheel to lose.

All the experiments made, as shown by the trials given abo
uniformly show that there is no advantage in loose wheels on the f
ward axle, even at the lowest speeds, but rather a disadvantage; t
the advantage is derived entirely from having a loose wheel on
back axle, notwithstanding the flanges of the forward wheels in
truck guide it on the rails, having increased friction thereby, a
the wheels on that axle have the same slip, or gain and loss, in co
forming their revolutions to the difference of the distances pas
over by them in the curve that occurs with the wheels on the ba
axle when tight.

The following sketch may assist in explaining the effect of the loose wheels on the back axle in passing a curve:



At slow speeds the flanges of the back wheels in the truck will scarcely touch the rail; and in most cases the wheels would keep the track if no flanges were on them, being kept in position by the forward wheels and truck frame. If the back wheels were tight on the axles, and allowed to run without being influenced by the forward wheels through the truck frame, they would continue on in a straight line toward *D*; and it is this tendency to continue toward *D*, or to go in a straight line, that constitutes the difference between loose wheels and wheels tight on the axles of a truck, so far as hauling power is concerned. To overcome this tendency of the back wheels to go in a straight line toward *D*, a force must be brought upon the truck frame in the direction of *E*, by the forward wheels, sufficient to slide the outer wheel on the back axle toward *H*, and the inner one toward *I*; and it is the friction in the boxes and of the flange of the outer wheel on the forward axle in the truck in overcoming the force necessary to slide the back wheels toward *H* and *I*, that makes the difference in hauling power between a truck having loose or independent wheels and one where the wheels are tight on the axles. When the wheels on the back axle are loose, then no force in the direction of *E* is necessary to *slide* one wheel toward *H* and the other toward *I*; they being independent adjust themselves in that direction, requiring but little if any expenditure of force by the forward wheels.

By reference to the trials given above it will be seen that as the speed is increased, the advantage in favor of loose or independent wheels decreases, until at speeds representing twenty-three miles per hour no difference could be detected between loose wheels or when tight on the axles.

At high speeds the wheels create a trembling or vibratory motion in the rails upon which they run; and while, theoretically, they are in perfect contact, yet practically, in effect at least, owing to this vertical vibration of the rails, the contact is somewhat imperfect, although the spaces passed over when the contact is not perfect may be infinitely small; yet it is more than likely that this is the reason why the difference in the speed changes the result. It has often been observed by those in charge of locomotives when hauling trains, that as the speed is increased the adhesion of the driving wheels decreases, noticeable particularly when the rails are slippery. This doubtless occurs from the same cause. For the same reason that objects placed upon a floor or smooth surface subject to vibration similar to that of the rails during the passage of trains at high speeds, easily arrange themselves and are moved by very slight causes operating upon them in a horizontal direction, so the wheels of a truck running at a high speed, owing to the vibrations of the track, much more readily adjust themselves to forces operating upon them in a direction at right angles from that of gravity, and the slip of the wheels on the rails, and their adjustment to their proper position, is more easily accomplished than at slow speeds. The vibrations referred to of course affect only the adhesion and that force required to adjust the wheels on the rails by sliding them.

As everything in connection with the models with which the experiments were made was as near perfect as was practicable, and great care was taken that they should be as accurate as it was possible to get them, and that each trial as reported was an average of from five to twenty, and the force of gravity was made use of for propelling power, there is no reason why the results should not be as accurate as if made on a larger scale.

A curve of three hundred feet radius is much shorter than those adopted on roads generally; and as the radius of the curve is increased the difference in favor of loose wheels decreases, and also

when the speed is increased to that in practice the advantages decrease so as to be scarcely perceptible even for freight trains; and then the fact that not more than ten per cent., on an average, of the roads in this country is curve, it would séem, on the whole, that the advantages that could be claimed for compound axles or loose wheels are not worth considering, to say nothing about the serious mechanical objections to such an arrangement.

The following trials were made to determine the difference *due to the gauge of the track* upon which the load was carried, all other conditions being equal. It will be remembered that in making the change from the gauge representing four feet eight and one-half inches to that of three feet no change of axles, wheels, boxes, or load was made, simply the adjustment of the wheels on the same axles to suit the gauge desired; the radius of the curve for each gauge being practically the same, so that whatever difference is shown in the results is *due to the gauge*.

Weight of Truck representing 9½ *Tons; Radius of Curve*, 300 *Feet.*

No. of Trial......	Incline of Track. (Grade.)..........	Average Speed per Hour.........	Average running Time............	Effect on Dial....	Gauge of Track.
51	1 in 41.68	5.76 miles.	29 sec.	1 degree.	4 feet 8½ inches.
52	1 in 51.10	5.76 "	29 "	1 "	3 "
53	1 in 40.87	7.59 miles.	22 sec.	5 degr's.	4 feet 8½ inches.
54	1 in 48	7.59 "	22 "	5 "	3 "
55	1 in 43.69	10.12 miles.	16½ sec.	15 degr's.	4 feet 8½ inches.
56	1 in 48	10.12 "	16½ "	18 "	3 "
57	1 in 29.47	16.70 miles.	10 sec.	Not used.	4 feet 8½ inches.
58	1 in 31.06	16.70 "	10 "	" "	3 "

By reference to trials 51 and 52 it will be seen that on the gauge

representing 4 feet 8½ inches, and track inclined 1 in 41.68, the truck ran down from the force of gravity at the rate of 5.76 miles per hour; but when the wheels were adjusted to the three feet gauge it was found necessary to reduce the incline to 1 in 51.10 to cause the truck to run at the same speed and produce the same results as when running on the 4 feet 8½ inch gauge. The power developed from the force of gravity of a load of nine and one-half tons on an incline of 1 in 41.68 would represent four hundred and fifty-five pounds, this being absorbed in rolling and other friction at an average speed representing 5.76 miles per hour. The power developed from the same load on an incline of 1 in 51.10 would represent three hundred and seventy-two pounds, or eighty-three pounds less. From this we find that the difference due to the gauge (all other things being equal) of a load representing nine and one-half tons, in a curve of three hundred feet radius, at a speed of 5.76 miles per hour, would be eighty-three pounds in hauling power in favor of the three feet gauge, or about eighteen and one-quarter per cent.

In trials 53 and 54 the difference due to the gague, at a speed of 7.59 miles per hour, is shown to be sixty-eight pounds in hauling power, or fourteen and one-half per cent. in favor of the three feet gauge.

In trials 55 and 56, made when the atmosphere was very warm and dry, at a speed of 10.12 miles per hour, the difference in favor of the three feet gauge is but forty pounds in hauling power, or about nine per cent.; and at a speed of 16.70 miles per hour, as shown in trials 57 and 58, the difference was but 32 pounds, or five per cent. in favor of the three feet gauge.

The above trials show conclusively that the advantage in hauling power in favor of the three feet gauge at the slow speeds in a curve *decrease* as the speed is *increased.* At a speed representing 5.76 miles per hour the advantage in hauling power was eighteen and one-quarter per cent.; at 7.59 miles, fourteen and one-half per cent.; at 10.12 miles per hour, nine per cent., and at 16.70 miles, only five per cent. in favor of the three feet gauge.

By placing the curve on an incline of 1 in 41.68, and adjusting the wheels of the truck to the four feet eight and one-half inch gauge, the average speed from the force of gravity represented 5.76

iles per hour; and when the wheels were adjusted to the three feet auge, the incline remaining the same, the speed averaged 11.13 iiles; and on an incline of 1 in 29.47, and the wheels on the four et eight and one-half inch track, the speed represented 16.70 miles er hour; and when adjusted to the three feet gauge the speed was icreased to 18.56 miles, the incline being the same in both cases.

The following trials were made to determine the difference between loose wheels" on a four feet eight and one-half inch gauge, and the ime on a three feet gauge, in a curve representing a radius of three undred feet:

No. of Trial......	Incline of Track. (Grade.).........	Average Speed per Hour.........	Running Time in Seconds.........	Effect on Dial...	Gauge of Track.	Cond'n of Wheels on Axles.........
59	1 in 52.80	6.42 miles.	26 sec.	8 deg.	4 feet 8½ in.	Loose.
60	1 in 52.80	6.42 "	26 "	6 "	3 "	"

From the above, which is an average of ten trials, it seems that hen the wheels are loose on the axles no difference in hauling ower due to the gauge is perceptible even at so low a speed as 6.42 iiles per hour. A great number of trials were made at speeds repsenting ten, twenty, thirty and thirty-five miles per hour, and no ifference due to the gauge could be detected when the wheels were ose on the axles, precisely the same amount of power being abrbed in friction by the truck in passing the curve on the three feet uge as when running on the four feet eight and one-half inch uge.

The following trials were made on the gauge representing four feet ght and one half inches to determine the difference in hauling wer due to the center of gravity of the load, relative to the center the track in the curve, the wheels being tight on the axles; the sults being an average of ten of each:

No. of Trial......	Incline of Track. (Grade.).........	Average Speed per Hour.........	Running Time...	Gauge of Track...	Center of Gravity of Load Relative to the Center of Track..........
61	1 in 42.81	6.42 miles.	26 sec.	4 feet 8½ inches.	In the center.
62	1 in 45.25	6.42 "	26 "	4 " 8½ "	10 per cent. more on inside.
63	1 in 46.58	6.42 "	26 "	4 " 8½ "	15 " " "

From the difference in the incline of the track in producing the same speed from the force of gravity as the speed was affected by the adjustment of the load, it is shown by the table above that where ten per cent. more of the load is carried by the inner rails of the curve a saving of five per cent. in hauling power is effected, and where the difference is fifteen per cent. more on the inner rails the saving in power is eight per cent.

The following trials were made, placing the curve on a *level* and an inclined straight track at one end of it, inclined 1 in 10.47. The truck at each trial was drawn up the straight incline to a pin placed at the point desired and then let go from that point, the truck starting itself and running down the incline from the force of gravity, the momentum thus acquired on arriving at the foot of the incline furnishing the power to propel it out on the level curve.

By reference to the table of trials giving the distance run on the incline and the distance run out on the level curve from the foot of the incline to the point where the truck stopped at each trial, it will be seen the effect due to the gauge, condition of the wheels on the axles, and center of gravity of the load relative to the center of the track, as shown by the difference in the distance run on the curve. The momentum of the truck would in all cases be the same, when entering the curve, when the distance run down the incline was the same.

No. of Trial......	Dist. run down the Straight Incline of 1 in 10.47.....	Dist. run out on Level Curve of 300 feet Radius	Gauge of Track..	Average Speed on Level Curve	Condition of the Wheels on the Axles.........	Center of Load relative to Center of Track run on.........
64	48 feet.	85 feet.	4 feet 8½ in.	Not given.	Tight.	Load in center.
65	48 "	112 "	3 feet.	" "	"	" "
66	48 "	121 "	4 feet 8½ in.	" "	Loose.	" "
67	48 "	121 "	3 feet.	" "	"	" "
68	122 feet.	213 feet.	4 feet 8½ in.	29.04 miles	Tight.	Load in center.
69	122 "	217 "	3 feet.	30.95 "	"	" "
70	122 "	228 "	4 feet 8½ in.	31.09 "	Loose.	" "
71	122 "	229 "	3 feet.	31.22 "	"	" "
72	122 "	218 "	4 feet 8½ in.	29.72 "	Tight.	10 per cent. inside of center.
73	122 "	228 "	3 feet.	29.04 "	"	15 per cent. inside of center.

The above trials as given are an average of from five to ten of each, the truck and load representing 9½ tons. The average speed on the curve in trials 64, 65, 66, and 67 could not be accurately given on account of the short distance run. In trial 64, when the wheels were adjusted to the four feet eight and a half inch track, the distance run on the curve represented 85 feet, and when adjusted to the three feet track the distance run represented 112 feet, being a difference in favor of the three feet gauge of 27 feet in distance, or about 31 per cent. It is proper, however, to explain that the difference occurred mainly in the last 20 feet run in trial 64, *when the speed was very slow*, and that for the first half of the distance run, when the speed was higher, but little difference was shown between that than when running the same distance over the three feet gauge in trial 65. The difference as shown in all the experiments made being greatest at the lowest speeds.

By reference to trials 66 and 67, when the wheels were loose on the axles, no difference whatever due to the gauge could be detected. It will be seen that the average distance run on the two gauges is precisely the same.

At the higher speeds, as shown in trials 68, 69, 70, 71, 72, and

whole distance run.

In trial 72, when ten per cent. more load was carried o
rail of the curve than on the outer, the distance run v
greater than when carried in the center, as in trial 68 on th
eight and a half inch gauge, and when fifteen per cent. more
was carried on the inner rail, as shown in trial 73, the differ
distance run was 11 feet greater than when in the center,
69 on the three feet gauge.

A series of trials were made by placing the curve on
of 1 in 44.30. At this incline the truck with the load
down the curve at an average speed of six miles per hou
little variation in the speed at any part of the curve, and
by running up an inclined straight track at the lower
curve. The straight track at the upper end of the curv
inclined to 1 in 26.18, and the truck was started fro
points on this incline, and running down on to the curv
hundred feet radius which was, as stated above, also at an
1 in 44.30. This inclined curve would cause the truck to
it at a speed of six miles per hour, with the wheels tig
axles, from the force of gravity, the wheels being on the fou
and a half inch track. If placed on the three feet gauge track
would have been about nine miles. By starting the truck fr
on the straight incline at the end of the curve, the speed at
truck entered the upper end of the curve would be kept
nearly uniform all through the curve, on account of the c
being at an incline sufficient to overcome the rolling and

The average of a number of trials produced the following results:

No. of Trial...........	Distance run down the straight Incline of 1 in 26.18 at upper end of Curve, Starting...	Speed in Miles per Hour passing over the Curve inclined 1 in 44.30, and Radius of 300 Feet............	Gauge of Track.	Condition of Wheels on the Axles..........
74	32 feet.	16.24 miles.	4 feet 8½ inches.	Tight.
75	32 "	21.81 "	3 feet.	"
76	32 feet.	28.05 miles.	4 feet 8½ inches.	Loose.
77	32 "	28.05 "	3 feet.	"
78	74 feet.	26.18 miles.	4 feet 8½ inches.	Tight.
79	74 "	29.20 "	3 feet.	"
80	74 feet.	35.70 miles.	4 feet 8½ inches.	Loose.
81	74 "	35.70 "	3 feet.	"
82	131 feet.	35.70 miles.	4 feet 8½ inches.	Tight.
83	131 "	35.70 "	3 feet.	"
84	131 feet.	39.27 miles.	4 feet 8½ inches.	Loose.
85	131 "	39.27 "	3 feet.	"
86	160 feet.	39.27 miles.	4 feet 8½ inches.	Tight.
87	160 "	39.27 "	3 feet.	"
88	160 feet.	39.27 miles.	4 feet 8½ inches.	Loose.
89	160 "	39.27 "	3 feet.	"

By reference to the above table it will be seen that in trials 74 and 75, the difference due to the gauge is shown in an increase of speed from 16.24 miles for the four feet eight and a half inch gauge, to 21.81 miles with the same load carried on the three feet gauge; the power derived from running down the incline at the upper end of the curve being precisely the same in both cases, the truck starting by its own gravity and from the same point—the run on this straight incline for trials 74, 75, 76, and 77 representing thirty-two feet. The incline of the curve and of the straight track from which the truck was started was not changed in this series of trials. The starting point of the truck on the *incline* was changed to represent the distances as given in the table above.

Trials 76 and 77 indicate that there is no difference in the hauling power due to the gauge, when wheels are loose, at a speed representing 28.05 miles per hour, and trials 78 and 79 show but little difference when the wheels were tight. At a speed of 35.70 miles per hour no difference could be detected, as shown in trials 82, 83—the power absorbed in rolling friction being the same in both cases, the load being carried at that speed by the same *power* applied as when carried on the three feet gauge track.

It will be seen by reference to trials made at a speed representing 39.27 miles per hour no difference could be detected, due either to the gauge of track or condition of the wheels on the axles.

The results of all these trials prove conclusively that at the higher speeds no advantage in hauling power is to be derived from the use of loose wheels or compound axles, and they also show that at speeds above twenty miles per hour but little advantage in hauling power can be claimed for the three feet gauge on a curve of 300 feet radius; and when the radius is increased the difference decreases in proportion. In some trials made on a straight track no difference due to the gauge could be detected, the load and all other conditions being the same in both cases.

It would seem from all the trials made, in order to determine the difference due to the gauge of the track, that in places where curves can be made, having a radius such as found in curves on the railways of this country, the advantages to be derived from carrying a given load on a narrow-gauge track over that of the standard gauge,

our feet eight and a half inches, is scarcely worth taking into ccount. At slow speeds, and if the line of road was *all* curves or early so, and those of short radius, the matter might be worth conidering on that account; but in a country such as ours, where there re but few places where curves can not be adopted having a radius f 600 feet or more, and where the standard and almost universal auge is four feet eight and a half inches, and where the interchange f cars is so desirable, it would seem that on the whole no advantage an be claimed for the narrow gauge. There may be exceptional ases where, on account of the topography of the country, a road rith moderate curves could not be made. In such cases the narrow auge might answer best, the ordinary gauge being impracticable.

If light machinery and light rails are desirable there seems to be o reason why the former can not be made to suit the four feet ight and a half inch gauge as light as may be desired, and no reaon why as light rails will not answer as well when laid to a gauge f four feet eight and a half inches as to a narrower gauge; besides, e wider gauge affords a broader base upon which to carry the load, nd a depression in one of the rails of a wide-gauge track will not roduce as much unsteadiness in the rolling stock passing over it as like depression in the track of a narrow-gauge road.

When we consider that, at speeds at which trains on railways are sually run, the difference in hauling power in favor of compound xles or "loose wheels," on a curve of so short a radius as 300 feet, scarcely percepitible at all on a gauge of track of four feet eight nd a half inches; and that the same is true as to the difference beveen carrying a load on a gauge of four feet eight and a half inches nd that of three feet, it would seem that the advantages claimed for ompound axles or "loose wheels" and for the narrow-gauge roads, far as hauling power is concerned, have been greatly overestiated by their advocates.

I have long been satisfied in my own mind as to that fact, yet uld give no proof of it, and it was as much to demonstrate these bjects to my own satisfaction as to answer the questions proounded in your circular that the above experiments were made, and you find anything of value or interest in the results of these exriments, and which may aid you in making up the report of your

Committee, I shall feel repaid for my labor in making this report to you.

Respectfully yours,

R. WELLS,

M. M., Jeff., Mad. & Ind'polis Railroad.

To M. N. FORNEY, *Chairman of Committee.*

On motion of Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad, the resolution recommended by the Committee was adopted.

Mr. COLEMAN SELLERS—In reference to the subjects reported on by the last Committee I would state that some years ago, when G. E. Sellers & Co. were considering the feasibility of three rails for roads, we tried an experiment to prove a theory we had that loose axles were the most advantageous. Instead of proving that theory it demonstrated exactly the opposite fact—that tight wheels are the best.

On motion the discussion was closed.

The Committee on Machinery and Appliances for removing Wrecks and Erecting Bridges presented the following report:

Machinery for Removing Wrecks.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee appointed to report upon the Machinery and Appliances for Removing Wrecks and Erecting Bridges, beg leave to report that they have issued their circular of inquiry containing the following questions:

1. Do you use other wrecking tools than hydraulic jacks, good levers, good tackle, and portable frogs?
2. Please give a schedule of tools in what you consider a perfectly equipped wrecking car.
3. Do you consider a derrick car, in addition to ordinary wrecking tools, desirable?
4. Do you know that ordinary wrecks can be removed with greater expedition with the aid of a derrick car?
5. Have you any new and desirable arrangement of cars or appliances for wrecking?
6. If so, please give a description or sketch.

Your Committee regret to say that they have received replies from only twelve roads, and as each of these is but a repetition of the other, they take the liberty of handing you that made by Mr. R.

Tells, of the Jeffersonville, Madison and Indianapolis Railway, hich appears to your Committee as being most comprehensive as ell as having the advantage of suggesting the use of a useful tool ther than those ordinarily used. Your Committee thank Mr. Robnson, of th eGreat Western Railway, for his full list of tools used, ut as there is no new appliance mentioned we refrain from copying t into this report. Your Committee find in the meagre replies beore them nothing recommending the exclusive use of a derick car in removing wrecks; this is due, perhaps, to the fact that it s impossible to establish any set formula by which all wrecks can e best removed, as each case is one of separate study and requires o be treated separately. Your Committee, from their own experince as well as from the information before them, can only recomnend a good assortment of strong lines, good blocks, jacks, and hand ools, kept in a tool car conveniently arranged for storing the tools nd ready for immediate use, and when needed to be handled romptly and with judgment.

Your Committee desiring to confine themselves within the scope f the objects of our Association, viz., that of collecting practical nformation from the *experiences* of the members, and knowing that he matter of erecting bridges does not come within the duties of the Master Mechanic, have refrained from following that subject as it ould necessitate an entirely separate set of inquiries, and from offiers of other departments in the railway management.

Very truly,

MORRIS SELLERS,
D. O. SHAFFER,
S. MOORE,
} *Committee.*

The following is the letter of Mr. Wells referred to by the Committee:

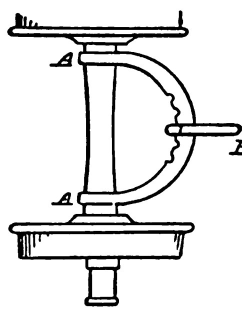
JEFFERSONVILLE, IND., *February* 15, 1873.

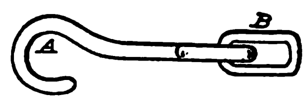
Morris Sellers, Esq., *Chairman of Committee on "Machinery and Appliance for Removing Wrecks and Erecting Bridges:"*

Dear Sir—In reply to your circular I answer question

1. No; except, perhaps, one or two articles that I have not seen use other places. One is a bar of iron about two by four inches, ent like the bale of a bucket, with a hook or turn on each end of

it large enough to hook over an axle close to each wheel, and which is used in pulling cars on the track when they may be off on one side of the track, or for "straightening" the truck toward the point to which it is desired to pull the car, and pulling the car by this "bale" the truck is kept directly in the line of draft. There is a loose link on the "bale" into which the hook of draft rope is hooked. When this link is put into center notch of bale the axle of truck will be held at right angles to the rope, and when put into the notch on either side of the center notch the axle will be held at a corresponding angle to the line of draft of the rope. The following is sketch of bale on axle:





By this bale a car (or truck or pair of wheels) can be pulled in almost any direction by putting it on to front axle and drawing by the link *B*, and "chaining" the back truck so as to keep it in line with the body of the car, etc. This may not be new to others, but I have not seen it in use elsewhere.

2. Having been so fortunate as not to have had much wrecking to do on this line I may not be familiar with the highest point attained in perfection of wrecking tools. I am unable, therefore, to name anything that is not or may not be embraced in your first question. *Strong* tools, such as named, with some one capable to direct the *best application of them*, will clear almost any wreck.

3. Have had no experience with derrick car in clearing wrecks and therefore can give no opinion from *experience*. In some cases they are desirable, while in many wrecks they can't be used to much advantage, would be my *opinion*.

4. Answer to third embraces about all I could say in answer to : fourth question.

5. Have not.

Respectfully yours,

R. WELLS, *Master Mechanic.*

On motion of Mr. Elliott, of the Ohio & Mississippi Railroad, the report s received.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I presume : gentleman would like to know what time we would prefer returning from ashington to-morrow; I therefore move that the hour be 5 o'clock P. M. Carried.

General D. D. Smith, Supervising Inspector General of the Steam Vessels the United States, was introduced to the Convention by President Britton, l spoke as follows:

Mr. PRESIDENT AND GENTLEMEN OF THE MASTER MECHANICS' ASSO-ATION—It gives me great pleasure to meet you on this occasion. At the t session of Congress before they adjourned they appropriated $100,000 to ry on some experiments by way of testing steam boilers and gathering ormation as to the causes of explosions. These experiments will proba- be made during the months of October and November next, before the xt meeting of Congress, when the report of the tests will be made to that ly. Last evening, while looking over a Washington paper, I learned that s Convention was being held in Baltimore, and made up my mind I uld take a trip here this morning to hear you speak and discuss matters ating to steam. As you are all interested in steam and the prevention boiler explosions, I have come to invite you to see the experiments made. e trials will be made at two points in different sections of the country— : point being either Pittsburgh or Cincinnati, the other Sandy Hook, New rsey. This is all I have to say on the subject. I know you are all inter-ed in the matter, and feel that your experience and skill as Mechanics ll be of great value in the solution of the questions to be determined. If u visit Washington to-morrow I shall be happy to see you in the Treasury partment, Room No. 28.

M. WELLS, Jeffersonville, Madison & Indianapolis Railroad—It seems to that it would be a good thing for the Association to appoint a Committee two Committees to attend the experiments to be made, alluded to by Gen-d Smith. For instance, if they make a series of experiments at Pittsburgh Cincinnati a committee from the West might to be appointed to attend d report to this Association at our next annual meeting the results of the periments. A similar committee might be appointed from the East to end the experiments at Sandy Hook; I therefore move that two commit-

tees be appointed by the President of this body to attend the experiments and report to the Association.

The motion was carried.

Mr. DURGIN, Pittsburgh Locomotive Works—I move that those committees consist of five members each.

Motion carried.

The Committee on Steel Tires presented the following report:

Report of Committee on Steel Tires, etc.

To the American Railway Master Mechanics' Association:

GENTLEMEN—The Committee to whom the subject of Steel Tires, Wheels and Axles, and Chilled Tires was referred, after giving the matter their attention and collecting the facts, respectfully submit the following report:

Assuming that the duties of the Committee were similar to those of the preceding year, they prepared a series of interrogations requesting replies from all the Master Mechanics of the country. The questions were as follows, viz.:

1. How many steel tires, and of what manufacture, are in use on your road?
2. Please furnish a detailed report of the performance of each set, stating the number of the set, thickness when fitted for use, present thickness, mileage, diameter of wheel, weight of engine, and nature of service.
3. Have any steel tires broken while in use on your road?
4. Please furnish statement of circumstances attendant upon such breakage: as the season of the year, the mode in which the tire was secured, the amount of shrinkage when set, the nature of the fracture, and extent of the damage in consequence thereof.
5. Have any steel tires on your road been removed from wheels on account of being worn so thin as to be considered unsafe? If so, of what thickness were said tires when removed, and what indications caused you to doubt their safety?
6. Is the location of your road such as to make your tire service particularly severe, on account of heavy grades or extremely cold weather?
7. What do you consider the best method of fastening steel tires to the wheels, and what rate of shrinkage do you allow in setting?

CHILLED TIRES.

8. How many chilled tires, and of what manufacture, have you in use on your road?
9. Please furnish detailed report of the performance of each set, mileage, diameter of wheel, weight of engine, and nature of service.

WHEELS.

. How many steel wheels, and of what manufacture, are in use on your , under engines or cars?

. In your experience, how do steel wheels compare with those of iron, ›int of durability, safety, and economy?

AXLES.

. How many steel axles, and of what manufacture, are in use on your , under engines or cars?

. From your own experience, do you think that their greater durability safety, as compared with those of iron, would justify the difference ›st?

nswers to the above were received from twenty roads, some very of information, while others were almost useless, owing to a of important items.

STEEL TIRES.

he reports have been carefully examined, and the Committee e endeavored to give a correct deduction from the facts before n.

'he whole number of sets of tire, reckoning four tires to the set, ›rted on is 1,383:

No. of Krupp's	manufacture	357
" Vicker's	"	113
" Firth's	"	294
" Butcher's	"	144
" Other	"	475
		1,383

›f the above we find details of 450 sets:

pp's	186	Bowling	4
:her's	34	Bolton	3
h's Nashua	11	Firth, English	77
›dom	5	French	5
Moor	4	Campbell	6
emer	1	Sheffield	3
cer's	95	Brown	1
hburne	2	Others	2
lor	11		
			450

The performances of the above will be found arranged in a table attached to this report.

From those of which we have the details we have derived the following result of all tires collectively:

Average run to 1-16 inch wear	16,634	miles.
Highest average on any road to 1-16 inch wear	65,500	"
Lowest " " 1-16 "	6,403	"
Highest run of any single set to 1-16 "	74,385	"
Lowest " " 1-16 "	1,274	"

From a digest of the statements of the returns, which are to be found in the table attached to this report, we derive the following result:

KRUPP'S—	Average run to 1-16 inch wear	17,614	miles
	Highest average on any road to 1-16 inch wear	70,000	"
	Lowest " " 1-16 "	6,303	"
	Highest run of single set to 1-16 inch wear	70,000	"
	Lowest " " 1-16 "	3,384	"
VICKER'S—	Average run to 1-16 inch wear	13,668	"
	Highest average on any road to 1-16 inch wear	25,819	"
	Lowest " " 1-16 "	4,484	"
	Highest run of single set to 1-16 inch wear	61,580	"
	Lowest " " 1-16 "	4,484	"
FIRTH, ENGLISH—	Average run to 1-16 inch wear	13,990	"
	Highest av. on any road to 1-16 inch wear	15,590	"
	Lowest " " 1-16 "	11,982	"
	Highest run of single set to 1-16 "	74,385	"
	Lowest " " 1-16 "	3,819	"
BUTCHER'S—	Average run to 1-16 inch wear	19,415	"
	Highest average on any road to 1-16 inch wear	61,000	"
	Lowest " " 1-16 "	7,448	"
	Highest run of single set to 1-16 inch wear	61,000	"
	Lowest " " 1-16 "	2,649	"
FIRTH'S NASHUA—	Average run to 1-16 inch wear	21,231	"
	Highest av. on any road to 1-16 inch wear	21,231	"
	Lowest " " 1-16 "	21,231	"
	Highest run of any single set to 1-16 inch wear	21,231	"
	Lowest run of any single set to 1-16 inch wear	21,231	"

OR—Average run to 1-16 inch wear........................ 10,476 miles.
Highest average on any road to 1-16 inch wear... 13,381 "
Lowest " " 1-16 " ... 7,571 "
Highest run of any single set to 1-16 " ... 15,727 "
Lowest " " 1-16 " ... 7,497 "
M—Average run to 1-16 inch wear... .... 8,036 "
Highest average on any road to 1-16 inch wear..... 9,089 "
Lowest " " 1-16 " ..... 7,275 "
Highest run of single set to 1-16 inch wear.......... 9,089 "
Lowest " " 1-16 " .... 7,275 "
—Average run to 1-16 inch wear........................... 10,684 "
Highest average of any road to 1-16 inch wear........ 14,234 "
Lowest " " 1-16 " .... 5,267 "
Highest run of single set to 1-16 inch wear............. 30,479 "
Lowest " " 1-16 " .... 3,205 "
LL—Average run to 1-16 inch wear......................... 10,542 "
Highest average of any road to 1-16 inch wear..... 12,643 "
Lowest " " " 1-16 " " ..... 8 441 "
Highest run of any single set to 1-16 inch wear... 19,762 "
Lowest " " " " 1-16 " " ... 5,963 "
—Average run to 1-16 inch wear............................ 15,129 "
Highest average on any road to 1-16 inch wear....... 22,083 "
Lowest " " " 1-16 " " .... 10,589 "
Highest run of any single set to 1-16 inch wear...... 37,101 "
Lowest " " " " 1-16 " " ...... 7,066 "
—Three sets reported, average............................. 8,749 "
URNE—Two sets reported, average........................... 8,361 "
N—One set reported, average.............................. 21,146 "
G—Four sets reported, average.............................. 8,543 "
ELD—Three sets reported, average.......................... 9,278 "
ER—One set reported, average............................... 22,030 "
—Two sets reported, average................................ 9,066 "
—One set reported, average................................. 19,848 "
WN—One set reported, average.............................. 9,804 "

Committee have given the figures as we find them, although
nt that there must have been inaccuracy in some cases.

BREAKAGE OF TIRES.

As shown in the table attached to this report, the number of tires broken since last report is as follows, viz.:

Krupp's	2
Vicker's	35
Firth's	2
Butcher's	9
Others	15
	63

The Central Railroad of New Jersey had four Butcher tires break; three broke while running in winter; put on by builders; shrinkage unknown. The other broke into five pieces while cooling off after being set on wheel; shrinkage allowed $\frac{1}{32}$ inch diameter to 4 feet 6 inch wheel. No damage resulted from any of the above.

Connecticut & Passumpsic Railroad report two Vicker tires broken; both broke in winter without any apparent cause; secured by set screws; neither broke through the screw holes.

Flint & Pere Marquette Railroad report one tire broken—tire made by Thos. Firth & Son, English; it broke through where it was counter-sunk for set screw; showed no defect in material; had run 75,000 miles before breaking; the amount of shrinkage unknown, as the tire was put on by builders—the Taunton Locomotive Manufacturing Company.

Lackawanna & Bloomsburg Railroad report three tires broken, all in winter months; maker's name not given. Two of the above were broken by too much shrinkage, no flaw or defect in tire being found. One of the above broke after running 50,000, showing a slight flaw across tread; the tire was secured by shrinkage alone.

Lake Shore & Michigan Southern Railroad (Michigan Southern Division) report as broken one each of Firth, Butcher, and Bolton; no details given.

Lake Shore & Michigan Southern Railroad (Toledo Division) broke twelve, as follows: One Butcher's tire broke through set screw hole; had run 99,800 miles. One Vicker's tire broke after running 2,910

iles; another of same set broke after running 108,650 miles; ickness when broke $2\frac{3}{16}$ inches; another of same broke—thickness hen broken 2 inches; secured by shrinkage alone—shrinkage $\frac{1}{16}$. ne Vicker's tire, $2\frac{5}{16}$ inches thick when broken; secured by $\frac{1}{16}$ rinkage. One Vicker's set—one broke after running 142,270 miles; ickness when broken $2\frac{1}{8}$ inches. One broke after running 144,300 iles. One broke having run 144,721 miles; thickness when broken $\frac{1}{16}$. One Vicker's—flaw in this set; previous mileage 62,895; ickness $2\frac{5}{16}$. One Butcher's set—one broke February, 1872; pre-ious mileage 48,990; $2\frac{1}{4}$ inches thick. One broke Feburary, 1873; ileage 92,519. Broke one February 1873; $1\frac{15}{16}$ inches thick. The bove all broke through set screw hole; shrinkage unknown.

Little Miami Road broke two tires—one Krupp's, secured by rinkage of $\frac{1}{16}$ inch; no damage. One Vicker's—shrinkage un-nown; no damage.

Rome, Watertown & Ogdensburg Railroad report one tire broken -Vicker's make; broken in very cold weather; thickness when roken $1\frac{5}{8}$ inches; mileage to date of breaking 104,100 miles; set ith wood between wheel centers and tire—S. S. Triggs's patent.

Terre Haute & Indianapolis Railroad report one Krupp's tire roken under a switching engine; thickness when broken $1\frac{1}{4}$ inches; cured by being shrunk on and held by large set screws.

Great Western of Canada reports three broken, caused by too uch shrinkage; but one broke through set screw hole, others broke rough clear metal; maker's name not given.

——— ——— reports thirty-one broken—twenty-three Vicker's; ickness when broken as follows: one $2\frac{5}{8}$ inches, one $2\frac{1}{2}$ inches, ur $2\frac{1}{8}$ inches, three 2 inches, two $1\frac{7}{8}$ inches, five $1\frac{3}{4}$ inches, four $1\frac{5}{8}$ ches, two $1\frac{3}{8}$ inches, one $1\frac{9}{16}$ inches; no cause assigned. Seven utcher's (English), one $2\frac{3}{8}$ inches, one $2\frac{1}{4}$ inches, one 2 inches, one $\frac{}{8}$ inch, one $1\frac{1}{2}$ inches, two $1\frac{7}{16}$ nches. One Freedom—thickness hen broken 2 inches.

REMOVAL OF TIRE.

There are but three cases reported, viz.:

The Lake Shore & Michigan Southern (Michigan Southern Divis-n) have removed some when worn to one inch in thickness.

The Little Miami Road removed four sets of $1\frac{1}{4}$ inch thickness, as one of them had broken under the same kind of engine and in the same service.

The Jeffersonville, Madison & Indianapolis Railroad have removed two sets because of their being loose and liable to split in cold weather; thickness when removed $1\frac{1}{8}$ inches.

SETTING AND FASTENING.

We have replies on these points from fifteen roads:

9 use shrinkage alone.

3 use shrinkage and set screws.

2 use set screws.

1 puts tire on with a bevel on the wheel and secured by bolts passing between the tire and the wheel, with a gib head on the out and a nut on the inside.

6 roads use $\frac{1}{100}$ inch to one foot in diameter shrinkage.

1 road uses $\frac{1}{64}$ inch to 16 inches in diameter shrinkage.

1 road uses $\frac{1}{16}$ inch to 5 feet tire shrinkage.

1 road uses $\frac{1}{20}$ inch to $4\frac{1}{2}$ feet tire, $\frac{1}{18}$ inch to 5 feet tire, shrinkage.

1 road uses $\frac{1}{32}$ inch to 5 feet tire shrinkage.

1 road uses $\frac{1}{40}$ inch to 51 inch wheel, $\frac{3}{100}$ to 56 inch wheel, $\frac{7}{100}$ to 62 inch wheel, shrinkage.

CHILLED TIRE.

Jeffersonville, Madison & Indianapolis Railroad report one set 42 inch chilled tire under switching engine; have run 48,000 miles and are about two-thirds worn out.

Port Huron & Lake Michigan Railroad report one set 54 inch switching engine; were taken off on account of being worn after running 40,000 miles.

STEEL WHEELS AND AXLES.

Cleveland & Pittsburgh Railroad report one driving axle; no signs of wearing out as yet; in use about three years.

Lackawanna & Bloomsburg Railroad report twenty-four steel

driving axles, equally divided between Krupp's and Nashua: think the greater durability justifies the difference in cost.

Lake Shore & Michigan Southern Railroad (Michigan Southern Division) have in use fifty steel truck wheels of Washburne's make; think them superior to chilled iron.

Lake Shore & Michigan Southern Railroad (Toledo Division) report twenty Washburne steel wheels; no details.

Terre Haute & Indianapolis Railroad have two pair Krupp's engine trucks, but think iron wheels the most economical; also have 152 steel axles, viz.: 70 Krupp's, 58 Vicker's, and 24 of Hussey, Wells & Co. under passenger and baggage cars; think increased cost will prevent their general use.

The Great Western Railroad of Canada prefers iron axles to steel when the former are hammered.

The Charlotte, Columbia & Augusta Railroad think iron as good as steel when the price is considered.

The Central Pacific Railroad prefers iron axles as regards economy.

The Little Miami Railroad has one pair steel trucks; would not recommend their adoption in place of chilled wheels; does not favor the use of steel axles.

The Northern (New Hampshire) Railroad has in use fifty-eight steel truck wheels, and in their opinion they are vastly superior to chilled wheels; for example, one pair have run under a heavy freight engine more than 65,000 miles, being more than double the wear of chilled wheels under the same engine.

The replies to inquiries in regard to steel wheels and axles have not been as full as we could desire; but, as far as heard from, the majority seem to be in favor of iron axles, considering the *difference in price.*

In submitting their report the Committee have only to regret that many of the returns to them contain so few details, and to express their opinion that many of the statements on which their deductions and averages are made must be erroneous, but they are given as returned to them. An examination of the details will show to each the inaccuracies referred to.

J. N. LAUDER, *Chairman of Committee.*

Report of Committee on Steel Tires, etc.

NAME OF RAILROAD.	KRUPP'S.				VICKER'S.				FIRTH'S.				BUTCHER'S.				LOW MOOR.				FREEDOM.				TAYLOR.			
	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set
Central of New Jersey																												
Central Pacific																												
Charlotte, Columbia & Aug.	1	16,384			3	20,910	23,947	15,048									2	13,381	15,727	11,567								
Cincinnati & Terre Haute						in	use	but	6	mos.																		
Connecticut & Passumpsic	3	17,424	37,012	6,607	6	10,507	19,759	7,938	11	14,198	74,385	3,819	1	16,466														
Flint & Pere Marquette	1	10,259							5	14,936	28,395	5,485	5	18,613	26,215	10,694					1	7,275			8	14,234	30,479	10,229
Jeffersonville, Mad. & Ind.					2	8,871	9,078	8,664																				
Lackawanna & Bloomsb'g	17	11,092	26,270	5,304	1	11,581							2	12,776	18,697	6,855												
L. S. & Mich. S. (M. S. Div.)	49	11,031	33,804	4,021	19	11,925	20,660	5,417	27	11,982	20,585	7,264	4	9,554	12,261	5,968					1	9,089			2	5,267	7,329	3,205
L. S. & Mich. S. (Tol. Div.)	19	17,849	39,712	9,589	14	25,819	61,580	13,073	24	15,590	22,947	9,369	7	27,840	39,054	4,656												
Little Miami																												
N. Y., B. & M. (D. & C. Div.)																												
Port Huron & Lake Mich.	1	70,000											1	61,000														
Raleigh & Gaston	6	9,475	13,609	6,880									4	7,448	10,877	2,649												
Rome, Watertown & Ogd.	8	17,308	25,897	8,472	14	17,477	32,269	10,023	4	13,243	15,783	10,985					2	7,571	7,646	7,497					1	12,553		
Terre Haute & Indianapolis																												
Unknown	74	11,135			35	11,342							8 En. 2 Am	10,371 10,664							3	7,744						
Gt. Western of Canada																												
Northern of N. H.	7	6,393	9,360	3,384	1	4,484																						

Report of Committee on Steel Tires, etc.

Firth, Nashua.				Campbell.				Petin, Gaudet.				Bolton.			
No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set	No. Set reported on	Average miles run to 1-16 in. wear	Highest run to 1-16 in. wear single set	Lowest run to 1-16 in. wear single set
11	21.231	51.087	10.357					2	12.717	15.940	9.495				
												1	7.787		
				4	12.643	19.762	6.5[illegible]0								
								1	10.589						
				2	8.441	10.920	5.963	2	22.083	37.101	7.066				
												2	9.712		

Washburne.		Brown.		Bowling.		Barrow.		N.* W.*		Unknown.		Sheffield.		Bessemer.	
No. Set reported on	Average miles run to 1-16 in. wear	No. Set reported on	Average miles run to 1-16 in. wear	No. Set reported on	Average miles run to 1-16 in. wear	No. Set reported on	Average miles run to 1-16 in. wear	No. Set reported on	Average miles run to 1-16 in. wear	No. Set reported on	Average miles run to 1-16 in. wear	No. Set reported on	Average miles run to 1-16 in. wear	No. Set reported on	Average miles run to 1-16 in wear
								1	19.848	1	9.804	3	9.278	1	22.030
		1	21.146												
2	8.361			4	8.543	2	9.066								

Report of Committee on Steel Tires, etc.

NAME OF RAILROAD.	No. Set of Steel Tires and Manufacturers.						No. Sets reported on	Miles Run to 1-16 Inch Wear.			No. and Make of Tire Broken.					
	Krupp's	Vicker's	Firth's	Butcher's	Others	Total		Ave'ge Run.	Highest Run Single Set	Lowest Run Single Set	Krupp's	Vicker's	Firth's	Butcher's	Others	Total
Central Railroad of New Jersey				40	40	80		No	details					4		4
Central Pacific						219		30,051								
Charlotte, Columbia & Augusta	7	3		4	3	19	6	17,735	23,947	11,567						
Cincinnati & Terre Haute	2					2		In use	but six	mos.						
Connecticut & Passumpsic River	3	6	12	1		22	21	13,712	74,385	3,819		2				2
Flint & Pere Marquette	1		16	5	20	42	33	17,513	51,087	5,485			1			1
Jeffersonville, Madison & Indianapolis	11	6	1	11	8	37	2	6,871	9,078	8,664						
Lackawanna & Bloomsburg	25		1	5	2	33	20	11,285	26,270	5,304						3
Lake Shore & Mich. South. (M. S. Div.)	105		210		110	425	103	11,255	33,804	3,205			1	1	1 Bolton	3
Lake Shore & Mich. South. (Toledo Div.)	19	11	24	7	11	75	75	18,988	62,629	4,656		8		4		12
Little Miami	18	16		2		36		No	details		1	1				2
N.Y., Boston & Montreal (D. & C. Div.)		2	2			4		No	details							
Port Huron & Lake Michigan			No	number	given		2	65,500	70,000	61,000						
Raleigh & Gaston	6			6	1	13	13	8,850	13,609	2,649						
Rome, Watertown & Ogdensburgh	8	14	4		9	35	35	16,047	37,101	5,963		1				1
Terre Haute & Indianapolis		3	10	32	1	46		No	details		1					1
Great Western of Canada	58	9	12	21 Phila.	34	134		No	tires	turned						3
Unknown	74	35		10	13	132	132	10,062	33,048	1,274		23		7 Eng.	1 Freedom	31
Northern of New Hampshire	20	3	1 Eng. 1 Nash.		4	29	8	6,043	9,360	3,384						

BRAND.	Average miles to 1st turning	Average miles to 1-16 inch wear	Average miles between 1st and 2d turning	Average miles to 1-16 inch wear between 1st and 2d turning	Average miles between 2d and 3d turning	Average miles to 1-16 inch wear between 2d and 3d turning	Total average miles to turning	Total average miles to 1-16 inch wear	REMARKS.
KRUPP'S	74 69,296	Set. 11,135	30 54,729	Set. 10,837	3 38,236	Set. 11,470	64,341	11,068	None of these tire broken.
VICKER'S	35 65,946	Set. 11,342	24 64,585	Set. 10,299	6 47,437	Set. 9,487	63,735	10,788	Of these 23 tire have broken; thickness when broken as follows: One 2⅝ in., one 2½ in., four 2½ in., three 2 in., two 1⅞ in., five 1¾ in., four 1⅝ in., two 1⅜ in., one 1 9-16 in. There has been one in addition to the above broken since Jan. 1, 1873.
English. BUTCHER'S	8 64,820	Set. 10,371	5 68,906	Set. 15,660	1 66,061	Set. 16,515	66,368	12,226	Of these seven have broken; thickness when broken as follows: One 2⅜ in., one 2¼ in., one 2 in., one 1 9-16 in., one 1½ in., two 1 7-16 in.
American. WM. BUTCHER	2 39,990	Set. 10,664	1 46,210	Set. 11,552	....	....	42,063	10,973	None of these broken.
FREEDOM	3 54,224	Set. 7,744	....	....	....	....	54,224	7,744	One of these broke since Jan. 1, 1873; thickness when broken 2 inches.
BOWLING	4 63,009	Set. 8,543	1 33,501	Set. 6,700	....	....	57,108	8,276	None broken.
BOLTON	2 58,470	Set. 9,712	....	....	....	....	58,470	9,712	None broken.
BARROW	2 36,264	Set. 9,066	1 41,633	Set. 20,816	....	....	38,054	11,416	None broken.
WASHBURNE	2 89,886	Set. 8,361	....	....	....	....	89,886	8,361	None broken.

On motion, report was accepted and Committee continued.

Mr. FRY, Grand Trunk Railroad—I would like to inquire whether, by accepting this report, it is to be printed in our minutes and considered as embodying the opinions of the Convention? If that is the case I think we should be careful in adopting such reports, particularly in the case of this one, as the Committee states much of the information is inaccurate.

THE PRESIDENT—The reports are printed in the minutes, but not as the sense of the Convention unless the Convention votes to make it so. It is to be printed for distribution.

Mr. ELLIOTT, Ohio & Mississippi Railroad—I will just state that I consider that report, so far as the wear of tires is concerned, almost valueless, as it does not give the weight of the engine or the weight on driving wheels. Without having these facts to consider I regard the report as to the surface of the tires almost valueless. You can take a light engine and a light set of tires and make four times the mileage that an engine will that weighs more. The Committee have given us no proper criterion for judging the results of their inquiries.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—It seems to me that a report of that character, to be of any value, should not only give the weight upon the wheels, but state the business done by the engine, whether freight or passenger; also, it should be made up from statistics showing each kind of tire worn out. The only correct estimate that can be made of the mileage of a tire is to take the size of the tire when it was put on, the size when it was worn out, giving the weight of the engine upon the wheels and the kind of business done, whether passenger or freight. Any other estimate is of little value.

Mr. KEELER, Flint & Pere Marquette Railroad—In connection with that I think the rate of speed should be added. It makes a good deal of difference whether a train is running twenty, thirty, or thirty-five miles an hour. The time should be specified in the report of the average—the average speed made by the engine.

Mr. EDDY, of the Boston & Albany Railroad—I agree with the gentlemen who have preceded me that the report on steel tires, as presented here, is entirely valueless. It does not give the weight of the engine, the rate of speed run, the size of the driving wheel, or the net service performed by the engine when not in the shop. On our road one engine ran about twelve months doing nothing but work on heavy grades. The thickness of the tires of that engine in running that time (and she probably run twenty or twenty-five thousand miles), with a four feet wheel and weighing thirty-three tons, was reduced more than half an inch. Another engine that we took into the shop the day before I came here we had run twenty-five months one hundred and ten miles a day, and probably during that twenty-five months she did not lay idle more than from six to ten days. That engine had a six feet wheel, and

is as heavy as the other one except one or two tons perhaps, and the thick-
ess of the tire was not reduced more than a quarter of an inch, according to
e best of my judgment. So you see that on the same road different sized
gines in a different service show results widely different.

Mr. PHILBRICK, Maine Central Railroad—I think we have got as much
formation on this subject at the present time as we are likely to have for
me years to come. The superiority of steel tires has been demonstrated,
d all that remains to be determined, which is the best steel tire and how
ick it should be for different kinds of engines. As it will be some years
fore the steel tires now in use wear out, we are not likely to obtain any
finite information on these points for some time to come. Some few years
ck a railroad gentleman expressed the opinion that the chill tire would
me into general use and supersede the steel tire. Meeting him some time
o I asked him how he was getting along with his chill tires; he replied
at he had been using steel tires for two years. The question of iron and
el tires is practically settled. What we want to know is which kind of
el tires to buy, and how thin they can be worn before they become unsafe.

Mr. EDDY, Boston & Albany Railroad—I agree with the gentleman in one
pect, that the question between steel and iron tires is settled; the question
what tire we shall use, the steel tire in preference to any other. The other
ng will not be settled for some considerable time. I do not believe we are
er going to be able to put down a rule as to the particular thickness the
e should have to be safe. Some roads will run tires down very thin. I
not believe our road would ever be able to run tires less than from an
ch and a half to an inch and three-quarters thick. Whenever they get be-
w that thickness I do not think we could place any dependence on them at
. Other roads, I suppose, will run them down from three perhaps to
ree-quarters of an inch. I would not be surprised at all if some roads
re them as thin as that.

Mr. SHAVER, Pennsylvania Railroad—I think we should have annual
ports on the wear of tires, Mr. President. If a uniform system of keeping
leage were adopted it would be a great benefit and advantage in forming
nclusions as to the value of different tires. I think we should all keep a
ok for that purpose, keeping a record of each train; then when a tire
re out the Association could tell just what it had done.

Mr. FRY, Grand Trunk Railroad—As one of the Committee to propose
bjects for consideration during the next year I would like to suggest a
an of keeping a record of tires, and to know whether it would meet the
ews of the Convention. The interest taken in the matter is evident from
e remarks of the gentlemen who have spoken. We need a system of keep-
g account of the life of a tire, and to make it uniform I would propose that
e questions asked by future committees on tires should be to every Master
echanic who takes out a tire, the original thickness of the tire when it

went in, the number of times it was turned, the number of miles the tire has run in its lifetime, giving the weight of the engine—the time and weight. These few figures would enable us to form some conclusions as to the relative value of tires. The main objects would be obtained by giving the lifetime of the tire, the number of miles run, the number of times turned, the cause of abandonment, whether from breakage or thinness of tire.

Mr. BROWN, Erie Railroad—This is a subject of considerable interest to our road. We would like to know how thin a tire can be run with safety. On some of our engines, weighing from thirty-six to forty tons, we run a tire down to an inch and three-eighths. Engines of thirty-six tons we run with tires as low as an inch and a quarter. We would like very much to know how the wear of tires is going with other roads.

Mr. EDDY, Boston & Albany Railroad—We run lighter engines than that, and never think of running the tire thinner than an inch and a quarter. I think it would be a good thing to add to the report the number of engines on each road, freight and passenger, and the thickness of the tire of each.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—In reply to Mr. Brown's question as to the thickness tires should have, I will state that some little time ago I removed two sets of tires from freight engines. One of them had a wheel five feet in diameter, the gauge four feet eight and a half inches. The engines were twenty-eight ton engines, and about two-thirds of their weight was on the driving wheels. We wore the tires until they were an inch and an eighth thick, and then removed them on account of stretching and getting loose. On removing them I found them somewhat rounded off on the inside, just as is the case with iron tires, but not so much as iron tires. I took another set out of a freight engine with a wheel of five feet diameter; they were an inch and three-eighths and had become loose. I measured them carefully on taking them out, and found that they were scarcely rounded at all on the inside. I lined them up and put them on again and turned them off. They are still running. When tires get as thin as an inch and a quarter it is my belief they nearly always get loose; but I think they could be run longer if that difficulty were overcome.

Mr. COLEMAN SELLERS, of Philadelphia—There are different hardnesses of steel tires, Mr. President, as we all know, and it strikes me we should have some uniform standard of hardness. In considering the wear on tires we must also take into account the weight resting upon the driving wheels, as Mr. Wells did in his test. As it is important that the tensile strength of the material in tires should be definitely known in the determining of the value of steel tires, I would suggest that the laboratory or workshop which we propose having should be provided with some standard knife-edge instrument which, by letting fall a heavy weight upon it, is driven into the steel and makes a gash which, by measuring, the hardness of the steel is determined.

Mr. Flynn, Western & Atlanta Railroad—We have used steel tires since 1866, and have taken off two sets in that time, not from their actually wearing out, but because we could not keep them tight without lining after a certain time, and then they would only run well for a short time. I think the adoption of some uniform shrinkage would be of benefit to the Association. My notion is that the shrinkage of a five foot tire should be the twenty-fifth part of an inch, and so on in proportion. It would be well, after investigation, for the Association to give some expression on this subject.

Mr. Philbrick, Maine Central Railroad—I would make a request, Mr. President, that in case of breaking tires a piece of the tire be obtained by drilling for deposit in the laboratory of the Association, of course with the history of the tire as to the points suggested by Mr. Fry and other gentlemen.

Mr. Hudson, Roger's Locomotive Works—It appears to me that any test of a tire after it is worn out does not show the condition in which the tire was originally. I apprehend the hardness would be proved by the use to which it had been subjected. The test afterward, so far as ascertaining what character of tire was likely to wear best, would be rather erroneous in my opinion.

Mr. Fry, Grand Trunk Railroad—When I was visiting some of the large railway shops of the United States, some time ago, I saw the process of putting tires on wheels in the New York Central shops. I understand the works we are to visit this afternoon have another system than the one I saw. It might be well for the members to investigate the matter on our visit to the shops of the Baltimore & Ohio Railroad this afternoon.

On motion of Mr. Flynn of the Western & Atlanta Railroad, the discussion of the subject was closed.

Mr. Robinson, Great Western Railroad—The Committee on Mechanical Labratory, wish to make a preliminary report, Mr. President. Such laboratories are common in Europe; one line of railway has one for its especial use. Unfortunately in this country we have no time to go into experiments on special subjects, but as an organization we can do so. If this laboratory is a success it will supply a great need. It will be a bureau where any inquiry upon a knotty point may be addressed with the certainty of obtaining intelligent information. In my opinion it will be a most valuable adjunct to the Association's means of usefulness. I would move the adoption of the following resolution:

Report of Committee on Mechanical Laboratory.

Resolved, That two more be added to our number, consisting of the President and First Vice-President of the Association, *ex-officio;* also, further,

Resolved, That in order to render the ensuing year useful for the purpose of this Committee and Convention generally, that a sum not exceeding $500.00 be voted from the Boston donation to be expended, if found necessary, in the purchase of a dynanometer and other instruments for the use of the Convention under certain regulations drawn up by this Committee.

The resolution was adopted.

The Committee on Colonel Gardner's invitation presented the following report:

Report of Committee on Col. Gardner's Invitation.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee who were appointed to take into consideration and confer with those wishing to avail themselves of the very kind offer of Mr. Gardner, Superintendent of the Pennsylvania Railroad, inviting those who might desire to take a trip over the Pennsylvania Railroad by daylight, would report that they have conferred with a great many of the members on the subject, the majority of whom would like to accept the invitation but do not think it possible for them to do so. Therefore your Committee would recommend that a vote of thanks of the Association be tendered to Mr. Gardner for his kind invitation, and our regrets for inability to accept the same.

Most respectfully,

SANFORD KEELER,
JOHN. L. WHITE,
L. S. YOUNG,
Committee.

The report was adopted.

The Committee on Place of next Annual Meeting presented the following report:

Report of Committee on Place of Holding next Convention.

H. M. BRITTON, *President of the American Railway Master Mechanics' Association:*

DEAR SIR—Your Committee appointed to select a place to hold the next Annual Convention, would recommend the following

places: Rocky Point, Rhode Island; Richmond, Virginia; New York City, and Cincinnati, Ohio.

Most respectfully,

B. W. HEALY,
W. BELL SMITH, } *Committee.*
J. I. KINSEY,

Mr. EDDY moved that the name of the city of Chicago be added to the list. Agreed to.

On motion, action on the report was deferred until after the election of officers, the next business in order.

ELECTION OF OFFICERS.

Mr. ELLIOTT, Ohio & Mississippi Railroad—If nominations are in order, I would nominate Mr. H. M. Britton for President of the Association.

There being no other nominations the Convention proceeded to ballot, when Mr. Britton received sixty-five votes and was declared elected.

Mr. BRITTON said—Gentlemen, I thank you very kindly for the vote which you have cast to-day, and for the confidence in me which that vote indicates. I can only repeat, as I have before, that I will accept the office with the best grace I can, and endeavor to perform its duties the best I know how. I thank you very kindly for the honor. The election of a First Vice-President is now in order.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I would like to know whether the Vice-Presidents, Secretary, and Treasurer may not be elected at one time?

THE PRESIDENT—No, sir; the constitution provides that the officers shall be voted for separately.

Mr. N. E. Chapman, Cleveland & Pittsburgh Railroad, was nominated for the office of First Vice-President and elected without opposition, receiving fifty-nine votes.

Mr. CHAPMAN said—Mr. President, and gentlemen of the Convention: I hardly know how to express my thanks for the honor conferred upon me. I can simply say that I will try to perform the *arduous* duties you have imposed upon me to the best of my ability. I thank you for the election.

For the office of Second Vice-President, Mr. Durgin nominated Mr. Wilson Eddy, of Boston; Mr. Robinson nominated Mr. J. H. Flynn, of the Western & Atlanta Railroad, and Mr. Wells nominated Mr. W. H. Robinson, of the Great Western Railroad.

Mr. Flynn declined, with thanks for the nomination.

On the first ballot, Mr. Eddy received 20 votes, Mr. Flynn 6, Mr. Robin-

son 24, Mr. Boone, of the Pittsburgh, Ft. Wayne & Chicago Railroad, 1, and Mr. Wells, of the Jeffersonville, Madison & Indianapolis Railroad, 1.

No election.

Mr. Robinson—Mr. President, I beg leave most respectfully to withdraw in favor of Mr. Eddy.

Mr. Eddy—I thought plurality elected?

The Chair—No, sir.

Mr. Eddy—I thank the gentlemen who have voted for me, and all others, most kindly, but beg leave to withdraw. I respectfully decline the office.

On the second ballot Mr. Robinson was elected, the vote standing: Robinson, 49; Eddy, 7; Kerr, 2; Philbrick, 1.

Mr. Robinson said—I thank you sincerely, gentlemen, for this expression of your confidence and respect. I can only say that, in accepting the position, I shall do all I can to further the interests of this Association, which I have greatly at heart.

For Secretary, Mr. J. H. Setchel, of the Little Miami Railroad, was re-elected, receiving sixty-two votes.

Mr. Setchel said—Gentlemen, I thank you for this exhibition of your confidence and esteem, and can assure you that my duties in the year to come shall be performed as they have been in the last two years. I am satisfied that experience will do something toward expediting the business of the office, and I desire to say that, if any member of the Association desires anything from the Secretary's office, let him ask, and he shall receive.

For Treasurer, Mr. Boone nominated Mr. S. J. Hayes, of the Illinois Central Railroad, who was elected without opposition, by the Secretary casting the vote of the Convention.

Mr. Setchel—I congratulate you, gentlemen, upon your re-election to the office of Treasurer of one of the oldest Master Mechanics in the country—one who has served us faithfully, and has taken a great interest in the welfare of the Master Mechanics' Association, S. J. Hayes.

Mr. Chapman—I move that a Committee on Resolutions be appointed.

Carried.

The President appointed as such Committee Messrs. Coleman Sellers, T. N. Losee, and T. W. Peeples.

Mr. Keeler, Flint & Pere Marquette Railroad—I move that the Supervisory Committee be designated as the trustees to take charge of the money donated to this Association by the citizens of Boston, as requested by them.

The motion was carried.

On motion of Mr. Garfield, the Convention adjourned to eight o'clock, P.M.

EVENING SESSION.

The Convention met at eight o'clock, P. M., pursuant to adjournment, President Britton in the chair.

Mr. Coleman Sellers, from the Committee on Premiums, presented the following report:

Report on Premium for Drawing.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee beg leave to report that they caused to be issued the following circular, which was published in leading papers:

PREMIUMS FOR DESIGNS AND DRAWINGS.

At the last Annual Convention of the American Railway Master Mechanics' Association a sum of money was appropriated by voluntary contributions, to be offered in premiums for the best design and drawing of a machine for removing snow from railroad tracks, and another for the best design and drawing of appliances for supplying locomotive tenders with water or fuel.

These drawings it was understood should be submitted at the next Annual Convention, to be held in Baltimore on the 13th day of May, 1873, and the undersigned were appointed a committee to determine which drawings and designs submitted at that time were the most deserving of the premiums. In assuming the trust imposed upon them by their appointment the Committee deem it best to state the conditions by which they will be governed in making the award.

The amount of money thus far subscribed is $125, which they propose to divide into two premiums of $75 and $50; one of these to be awarded for the best drawing of machinery for removing snow, and the other for the best drawing of arrangements for supplying water or fuel to locomotive tenders, whichever drawing the Committee may determine has the most merit to receive the larger premium.

In determining the relative merits of the designs and drawings the Committee will be guided by what they conceive to be the most important which should be arrived at in making them. These are:

First, That the machine or appliance represented should be the best adaptation of means for accomplishing the required ends;

Second, That its construction should be clearly and perfectly shown, and

in such a way as to guide mechanics in the most plain and certain way in making what is represented;

Third, That the drawing should be skillfully executed, but it should be remembered in making drawings of this kind that *mechanical results* are more important than pictorial effects.

It should be understood that the premiums are not offered for the best design or idea *alone*, nor for the best representation of an idea, but for the best combination of skill in delineation and sound judgment in selecting and devising the best arrangement and proportion of parts for accomplishing the purposes named. Nor is it requisite that the design should be either new or original. The Committee will not, however, consider themselves bound to make any award should there not be any drawing of adequate merit, nor will any distinction in this matter be made between any persons whatever.

The drawings should not exceed three feet in length nor two feet in width, and should be neatly but inexpensively framed. The latter will, however, not be required.

M. N. FORNEY, 72 *Broadway, New York*,
COLEMAN SELLERS, *Philadelphia*,
W. S. HUDSON, *Paterson, N. J.*
} *Committee.*

In spite of the clear statement that the premium was for drawings only your Committee are in receipt of of photographs and models, as well as printed cuts of various devices for the purpose of removing snow, all of which are laid aside as inadmissible without comment.

In reference to the supply of fuel and water they have received but two specimens, one an elaborately finished drawing, the other a tracing from a very well made drawing. In regard to the merits of the two, both well-known devices, the opinion of your Committee is decided as to the merits of the drawings presented, and are united in the merits of the drawing printed. They consider that there is but little difference in the merits of each, but are unanimous as to the skill displayed in the drawing. They therefore recommend the awarding of the First Premium of $75 to E. Moyel, of Kansas Pacific Railroad, for apparatus for supplying locomotive tenders with water, which is herewith presented.

But three drawings have been submitted for methods of removing snow from railroad tracks. The one received from Mr. Frank Philbrick, of Waterville, Maine, is the only one admissible either

for design or execution; and for this drawing they recommend the Second Premium of $50 to be awarded.

M. N. FORNEY,
COLEMAN SELLERS, } *Committee.*
W. S. HUDSON,

On motion of Mr. Elliott, of the Ohio & Mississippi Railroad, the report was received, and the recommendations were adopted.

The next business in order being the consideration of the report of the Committee on Place for Holding the Next Meeting, the report and the amendment to it were read.

Mr. Gorman moved that St. Louis be added to the list.

Lost.

On motion of Mr. Eddy, of the Boston & Albany Railroad, the Convention proceeded to select a place by ballot. The result of the first ballot was as follows:

Chicago, 50; New York, 11; Cincinnati, 7; New Orleans, 3; St. Louis, 1; Richmond, 1.

On motion, the choice of Chicago was made unanimous.

THE PRESIDENT—I will now appoint, as the two committees to attend the experiments of the United States Government in regard to steam, Messrs. R. Wells, C. R. Peddle, J. H. Setchel, S. M. Cummings, and N. E. Chapman, for the West, and Messrs. A. B. Underhill, H. L. Brown, J. H. Flynn, Thomas Kerr, and W. A. Robinson, for the East.

On motion of Mr. Boone, of the Pittsburgh, Ft. Wayne & Chicago Railroad, the President of the Association was added to both Committees.

Mr. Forney, of the Railroad Gazette, was called upon to read the following paper, prepared by him on the subject of slide valves:

A Proposed Method of Testing Graphically the Actual Motion of Slide Valves.

The manner of representing the movement of slide valves by what are called motion curves has often been described in treatises on the steam engine. As some modifications in the application of this method are proposed, and as possibly some who are present may not be familiar with it, a brief description may not be amiss.

Let us suppose, then, that we want to represent by a drawing the movement of an ordinary slide valve in relation to the piston during the whole of the stroke. To do this we will suppose, first, that the parallelogram *A*, *B*, *C*, *D* (Fig. 1), represents a section of a cylinder

Report of Committee on Steel Tires, etc.

NAME OF RAILROAD.	No. Set of Steel Tires and Manufacturers. Krupp's	Vicker's	Firth's	Butcher's	Others	Total	No. Sets reported on	Miles Run to 1-16 Inch Wear. Ave'ge Run.	Highest Run Single Set	Lowest Run Single Set	No. and Make of Tire Broken. Krupp's	Vicker's	Firth's	Butcher's	Others	Total
Central Railroad of New Jersey				40	40	80		No	details					4		4
Central Pacific						219		30,051								
Charlotte, Columbia & Augusta	7	5		4	3	19	6	17,735	23,947	11,567						
Cincinnati & Terre Haute	2					2		In use	but six	mos.						
Connecticut & Passumpsic River	3	6	12	1		22	21	13,712	74,385	3,819		2				2
Flint & Pere Marquette	1		16	5	20	42	33	17,513	51,087	5,485			1			1
Jeffersonville, Madison & Indianapolis	11	6	1	11	8	37	2	8,871	9,078	8,664						
Lackawanna & Bloomsburg	25		1	5	2	33	20	11,285	26,270	5,304						3
Lake Shore & Mich. South. (M. S. Div.)	105		210		110	425	103	11,255	33,804	3,205			1	1	1 Bolton	3
Lake Shore & Mich. South. (Toledo Div.)	19	14	24	7	11	75	75	18,988	62,629	4,656		8		4		12
Little Miami	18	16		2		36		No	details		1	1				2
N.Y., Boston & Montreal (D. & C. Div.)		2	2			4		No	details							
Port Huron & Lake Michigan			No	number	given		2	65,500	70,000	61,000						
Raleigh & Gaston	6			6	1	13	13	8,850	13,609	2,649						
Rome, Watertown & Ogdensburgh	8	14	4		9	35	35	16,047	37,101	5,963		1				1
Terre Haute & Indianapolis		3	10	32	1	46		No	details		1					1
Great Western of Canada	58	9	12	21 Phila.	34	134		No	tires	turned						3
Unknown	74	35		10	13	132	132	10,062	33,048	1,274		23		7 Eng.	1 Freedom	31
Northern of New Hampshire	20	3	1 Eng. 1 Nash.		4	29	8	6,043	9,360	3,384						

BRAND.	Average miles to 1st turning	Average miles to 1-16 inch wear	Average miles between 1st and 2d turning	Average miles to 1-16 inch wear between 1st and 2d turning	Average miles between 2d and 3d turning	Average miles to 1-16 inch wear between 2d and 3d turning	Total average miles to turning	Total average miles to 1-16 inch wear	REMARKS.
KRUPP'S	74 69,296	Set. 11,135	30 54,729	Set. 10,837	3 38,236	Set. 11,470	64,341	11,068	None of these tire broken.
VICKER'S	35 65,946	Set. 11,342	24 64,585	Set. 10,299	6 47,437	Set. 9,487	63,735	10,788	Of these 23 tire have broken; thickness when broken as follows: One 2⅝ in., one 2½ in., four 2⅜ in., three 2 in., two 1⅞ in., five 1¾ in., four 1⅝ in., two 1⅜ in., one 1 9-16 in. There has been one in addition to the above broken since Jan. 1, 1878.
English. BUTCHER'S	8 64,820	Set. 10,371	5 68,906	Set. 15,660	1 66,061	Set. 16,515	66,368	12,226	Of these seven have broken; thickness when broken as follows: One 2⅜ in., one 2¼ in., one 2 in., one 1 9-16 in., one 1½ in., two 1 7-16 in.
American. WM. BUTCHER	2 39,990	Set. 10,664	1 46,210	Set. 11,552	....	....	42,063	10,973	None of these broken.
FREEDOM	3 54,224	Set. 7,744	....	....	....	....	54,224	7,744	One of these broke since Jan. 1, 1873; thickness when broken 2 inches.
BOWLING	4 63,009	Set. 8,543	1 33,501	Set. 6,700	....	....	57,108	8,276	None broken.
BOLTON	2 58,470	Set. 9,712	....	....	....	....	58,470	9,712	None broken.
BARROW	2 36,264	Set. 9,066	1 41,633	Set. 20,816	....	....	38,054	11,416	None broken.
WASHBURNE	2 89,886	Set. 8,361	....	....	....	....	89,886	8,361	None broken.

After the diagram is drawn the extreme movement of the horizontal arm should be noted and the vertical arm then be disconnected from the valve stem. The pencil should then be placed in a position midway between that of its extreme throw, and the arm and shaft A then be fastened securely by a nut N (Fig. 6.) By moving the cross-head the pencil will then draw a horizontal line G, H (Fig. 5), which, if the valve throws equally on each side of the valve face, will represent the center line of the latter, and the curve which has been drawn will represent the motion of the center of the valve. The parts can then easily be drawn on the paper from the center line, and by drawing the same curves for each edge of the valve its actual motion in relation to each part and for each function which it has to fulfil, can thus be accurately represented. Of course, if the valve travels unequally on each side of the center of the valve face, allowance should be made therefore in order to arrive at correct results.

It is believed that this method of testing valve gear will indicate more clearly than any now in use the defects which may exist, and that with the use of the indicator, to show the actual pressure of steam in the cylinders, it would frequently reveal the existence of very serious defects, whose existence would otherwise not be suspected, or at least not discovered.

Very little claim for originality can be made for the suggestion, as it is simply an adaptation of a somewhat similar method which has been used on models of valve gear to the locomotive itself. It has, however, not been applied to the knowledge of the writer as is proposed in this paper, and if it should be found to be useful to any who are present the object in preparing this description will be fully accomplished.

M. N. FORNEY,
Mechanical Engineer.

On motion of Mr. Garfield the thanks of the Convention were tendered Mr. Forney for the preparation of the paper.

. F. B. Miles, of Philadelphia, read the following paper:

ou may, perhaps, find it not uninteresting nor unprofitable on occasion to consider with me for a brief space the subject of

Power and our Responsibility as an Association with egard to the Quality of Material, Workmanship, and esign used in Railroad Service.*

ow we all of us like to see the best work, and we all prefer to the best material, and we all experience a high degree of satis-on when we find these combined in a first-class design. By -class design we understand not merely the most agreeable ngement of parts, though that also is a good thing, but we mean in which both workmanship and material are employed together he best mechanical advantage; then our sense of right and ce is satisfied as well as our taste, and we know and feel that in ing the thing, whatever it may be, there has been the least pos- waste of time and brains and money, and that we have got the pest thing for the purpose. Somehow or other there seems to considerable pressure brought to bear to prevent us from getting nese good things.

o one openly advocates the use of bad rails, or weak bridges, or rs, or axles. Every one knows that a single accident, whether a broken rail, or bridge, or axle, frequently costs a company in dollars and cents, to say nothing of life, than a mile of track a good bridge in it and a locomotive on it. Every one knows nd yet in too many cases, by some means or other, we continue et hold of the bad article; and we can not always get the good by paying the highest price for it. Well, what can we do about We try all we know, but do not seem to have much power to edy the evil. (There is a great difference of opinion as to what est, some think one thing and some another.) We are hampered uch and such difficulties: some roads are poor, we are obliged to conomical. All the powers of fogyism and false economy are yed against us, and all the "*vis enertia*" of the "let-well-enough-

*w the DESIGN of this article has reference only to our Convention, and has nothing with the material or workmanship used on railroads. Its main idea is to get this ntion to give its verdict, and publicly express what it knows. For "to know a thing ot express it, is all one as if we knew it not." So says a wise Greek.

alone" kind of people. This is all no doubt very true. "'Tis true, 'tis pity, and pity 'tis, 'tis true." But then difficulties were made to be overcome not to be bewailed; and the question is whether we HAVE tried all we know.

In there not one thing which we have *not* tried, and which we ought to try? a power of which we are perhaps not fully conscious, which is as yet only partially developed, and of such recent origin that we have hardly had time to recognize it—and that is the power of this Association! *

Has any one of us ever thought sufficiently about it?—the power that we can exercise through our Association toward elevating the standard of railroad engineering practice, and the responsibility which this power entails upon us? It is a very serious question and well worthy the attentive consideration of this society. Let us look at it a little.

We have hitherto used this Convention only to perfect our own knowledge; to collect information and combine our experiences, our observations, and our experiments for the good of all who may choose to profit by them, and it is a most worthy and excellent object. But is there not another and equally valuable service which it can render us by using its influence and moral power to establish a higher standard of criticism in all matters pertaining to our profession? By recommending the highest excellence in all engineering practice? By organized remonstrance to all second rate and inferior performance? and by delivering its verdict upon the subjects that come up before it for discussion? So long as we had no Association, each Master Mechanic depending upon himself alone, and having to fight as it were upon his own hook, was comparatively powerless, and his responsibility was measured by his power, or by the want of it rather. But now, that we have availed ourselves of the grand principles of association and organization, the case is widely different. Our power is multiplied as the square of our number. Singly we conducted more or less of a guerilla warfare; now we are a disciplined army. Our scattered opinions might be

* Our Secretary has mentioned that people often ask him why we do not come to some definite conclusion on certain topics and announce that as our verdict. That shows conclusively what they expect of us.

regarded as individual prejudices. But the deliberate conclusions of this Convention have the authority of public opinion, and that is one of the strongest forces in modern society. No abuses can long stand against it. For look you, Mr. President, at this assembly before you. This is not merely a company of gentlemen met to discuss mechanical affairs; look closer, it is much more than that; it is a council of *experts* gathered from all parts of our country; among their number you will find gentlemen of ability and education that would grace any society. Others, who though without the advantages of collegiate education, have actually got more book knowledge than one-half the college professors in the country. Some again chosen for their energy and administrative faculty, others for their keen practical knowledge of their profession.

The authority of such a council of experts must needs have a very great influence. Any decision they make they can enforce; any requirements they exact must sooner or later be complied with; any reform they adopt they can carry out. But that is not all; look still deeper; see their grave and serious responsibility. These are the men to whose skill and judgment, right or wrong, the whole community entrusts its lives and its property—indirectly, it is true, but still intrusts them absolutely and without reserve—and they must prove themselves worthy of the trust reposed in them by the community.

We look back over the long, terrible catalogue of the disasters that have occurred since our last meeting, on sea and shore, and we can not but feel that we must not shrink from the responsibility that rests upon us.

Well, what more can we do besides faithfully discharging the duties of our station? Why, we must do *more* than our duty if we would excel. It's the extra work that tells. No man ever did excel who confined himself to merely doing his duty.

Nelson's well-known signal at the battle of Trafalgar, "England expects that every man this day will do his duty," made a great sensation in the time of it, and the English HAVE done their duty nobly. But the time is now ripe to go them one better, and I hope I am only saying what we all feel when I say "that might be all

very well for England then, but America now expects a great deal *more* than that, and means to have it!"

Take our most eminent engineers—the men who have ennobled and dignified our calling and made us proud of being mechanics, the HEADLIGHTS of our profession, the men whose name and fame were among our strongest incentives in early life to make the best design we could out of our own raw material—did they achieve their eminence by doing only their duty? Take the distinguished members of our own society. Did you, Mr. President, become our chairman through doing only your duty? Did the founders of this Association confine themselves to their strict duty in founding it? By no means!

Then neither must we as a body content ourselves with doing only our duty. We must do everything in our power to contribute to the world's progress. We must assume an attitude worthy of the dignity of our profession, and of this Association, and of the responsibility imposed upon us by the community. We must *set an example*, make our power felt, issue our decision and create public opinion by announcing it as the avowed policy of this Convention, so far as our influence goes, to admit none but FIRST-CLASS MATERIAL, WORKMANSHIP, and DESIGN into our railroad service!

And then down come the old fogies upon us like a flock of turkey buzzards! But we must not mind them; they can't hurt us much if we are alive; they are only dangerous to dead or helpless things. Ever since the world began they have opposed each reform, each attempt at improvement, and *always* been whipped every time, and still never learn any better.

Now, what is an old fogy? It is well to mean something definite, and by an old fogy is meant a man who *doesn't dare to do his own thinking*, but is always adopting the cut-and-dried opinions of some one else, generally of his predecessors. Of course he don't belong to this Association—that would be impossible. No, Mr. President, the old fogies are comprised entirely among those who are not members.

There is a feature in the natural history of crabs which illustrates fogyism very clearly. It is the season now in Baltimore for soft-shell crabs, and the figure is therefore appropriate. Well, the story

goes that whenever a crab casts his shell some of the soft fogy kind are always on the watch, and one of them immediately runs and fits himself into the cast-off shell. Then he's a conservative!

There never was but one man in all history, so far as I have read, who could have done any real good by being an old fogy; and that man was Adam! If he had let well enough alone we might have been better off!

Well, we don't mean to let the fogies get the best of us by any means; we mean to give them another good whipping. The proposition is that we are "*bound to employ none but first-class material, workmanship, and design in every department of our service.*"

Some of us might say hastily, on the first impulse, "Why, of course, that is just our object—that is just what we are aiming at. We are met here in convention for the very purpose of learning the best means of obtaining these things and of taking care of them after we have got them."

Well, these gentlemen would be in the right direction, certainly, but not altogether in the attitude I would like to see them take.

In your opening address, Mr. President, you stated how nearly we had approached the present limit of our facilities for railroad transportation. Well, sir, there are many occasions in the history of human progress when we begin to find we have worked up too close to our idea of perfection, and it then becomes necessary to pull up the old landmarks and guide-posts which we have overtaken, and to set them out ahead again for a fresh start. This is one of those times now, and it is the natural and proper province of associations like ours to move the stakes and establish the higher idea, and to set the tone and strike the key-note of a fresh stage of progress.

Science has reached its present state of advancement by the efforts of our predecessors straining after a degree of perfection that was at first far removed from them. It is now our turn to take it forward another stage. And let us not set the mark too near to our present position where we shall soon again overtake it. Let us rather place it far above and ahead of us, where we can look up at it and strive after it for a long time before reaching it.

The right thing for us to say, therefore, and that which I am sure would best express the sense of this meeting, would be something

like this: "None but the best shall be recommended for admittance on our roads. We will have nothing else if we can help it, and we don't know anything else. We will recommend it in every department—nothing less will satisfy us. We will not accept or tolerate any second-rate thing, nor lend it our aid and countenance in any way or shape; but will protest against it and use all our influence against it, so far as in us lies, if it be not first-class of its kind," and not only the best we can get, but the very best it is possible to make.

There is no doubt that we all feel this, and believe it, and act upon it as far as we can; but the thing is to SAY it as the verdict of this Convention. We shall then be doing a good work, and advancing the best interests of our profession. All who have any ideas of improvement will sympathize with us; all the progressive men who are not members of our Association will heartily join hands with us. I respectfully submit that one good purpose of this Convention will be served if we all go home with a more realizing sense of our power and our responsibility with regard to this subject.

F. B. MILES.

BALTIMORE, May 13, 1873.

On motion of Mr. Keeler the paper was received.

Mr. Fry, from the Committee on Subjects, presented the following report:

Report of Committee on Subjects for Next Meeting.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee appointed to select subjects for discussion at the next Annual Convention respectfully suggest the following, and hereby submit them to your consideration:

The Operation and Management of Locomotive Boilers, including the Purification of Water.

Fuel—Actual Consumption per Ton per Mile of each Kind of Fuel Used, and also the best Form and Proportion of Fire Box, and the Proper Proportion of Tube Surface to Grate Surface requisite to Produce the best Results in the Consumption of Coal.

The best Form of Safety Valves, or Method of Relieving Boilers of Overpressure, and the best Way of Testing Pressure Gauges.

Valves and Valve Gearing.

Tires—The Thickness of Tires when put in and when taken out of Service, the number of times Turned during Service, the total number of Miles Run, the Size and Weight of each Wheel, the Kind of Service and Maker's Name.

Lubricants used for Machinery and Cylinders of Locomotives, and number of Miles Run per Quart of each Special Kind.

Standard Axles.

Apparatus for Supplying Water to Tanks of Water Station, Description of Engine, Windmill, etc., and Cost Working the Same.

Narrow and Broad Gauge Rolling Stock.

C. R. PEDDLE,
HOWARD FRY,
A. B. UNDERHILL, } *Committee.*

On motion of Mr. Elliott, the report was received.

On motion of Mr. Street, of the Pennsylvania Railroad, the subject of Continuous Train Brakes was added to the list.

The President—Gentlemen, there are two persons who have made application for Associate Memberships in this Association, whose names the Secretary will read.

To the American Railway Master Mechanics' Association:

Gentlemen—The undersigned recommend to you for Associate Membership, L. D. Bartlett, Manager of Steam Engine Department Putnam Machine Company, Fitchburg, Massachusetts.

Very respectfully,

A. B. UNDERHILL,
JNO. THOMPSON,
WM. H. GRIGGS.

To the American Railway Master Mechanics' Association:

Gentlemen—Edwin Harrington, Manufacturer of Lathe and Machinists' Tools, Philadelphia, Pennsylvania, is respectfully proposed for Associate Membership, by

WM. WOODCOCK, *C. R. R. of New Jersey,*
ISAAC DRIPPES, *Philadelphia,*
H. D. GARRETT, *Pennsylvania R. R.*

THE PRESIDENT—It is necessary there should be a committee of three to whom the names shall be referred. I will appoint on that committee, Mr. Curtis, of the P. C. & St. Louis Railroad, Mr. Philbrick, of the Maine Central Railroad, and Mr. Kinsey, of the Lehigh Valley Railroad.

Mr. FRY, Grand Trunk Railroad—I would like to inquire how many vacancies for associate members we have?

THE PRESIDENT—The Constitution provides for twenty; we now have twelve.

Mr. CHAPMAN, Cleveland & Pittsburgh Railroad—At our annual meeting in Pittsburgh I was chairman of the committee appointed the year before in Cleveland to recommend a standard size for nuts. We made our report at Pittsburgh. Last year, at Boston, a committee from the Association of Bolt and Nut Manufacturers of the United States called upon the Committee, or rather upon the Convention, in regard to some of the sizes recommended, and the matter was referred to the Committee again. I have met with one member of the Committee, Mr. Smith, the other member is not here. I have also met the Committee from the Bolt and Nut Manufacturers of the United States, and we recommend the following report for adoption:

Report of Committee on Standard Size for Nuts.

To the American Railway Master Mechanics' Association:

Your Committee appointed at the last Annual Meeting to confer with a committee appointed by the Association of Bolt and Nut Manufacturers of the United States upon the subject of uniform standard size of nuts, would recommend the adoption of the sizes of nuts as adopted by the Manufacturers' Association at their meeting December 11, 1872.

Most respectfully submitted,

N. E. CHAPMAN,
L. S. YOUNG.

On motion of Mr. Flynn, of the Western & Atlanta Railroad, the report was received and adopted.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I move that the appointment of committees by the President be postponed until such time as he sees fit to appoint them, and that he notify the members so appointed by mail.

The motion was carried.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—I move that the Supervisory Committee of this Association consist of the same mem-

s that it did last year, with the substitution of Mr. Robinson, our Second ce-President for his predecessor.

The motion was carried.

Mr. Coleman Sellers, from the Committee on Resolutions, presented the lowing report:

Report of Committee on Resolutions.

the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee report that, upon inquiring into e circumstances attending the hospitality that has been extended the members of this Association by the citizens of Baltimore, ey find the noteworthy fact that the contributors to this fund are izens who have no pecuniary interest in the matters over which embers of this Association have control, but who have been in- enced by the kindest feelings toward those who have charge of e machinery of the railroads that contribute to the general wealth the nation. It has been freely given, with the knowledge that e meeting of the Association in this beautiful city is to increase usefulness by interchange of thought and the mutual improve- ent of its members.

Your Committee, in the resolution herewith submitted and offered your approval, desire to call your attention to the hospitality iich has been so generously extended, not only to the members of e Association, but in such an admirable manner to the ladies who ve accompanied the members from their various homes in all arters of the land; to note the flattering attention of the press reporting our proceedings, and who have evinced a greater interest our success than we have noted in any city where we have pre- ously met.

The visit to Annapolis by boat, with all its pleasant associations, e delightful ride to the park, are fresh in the memory of those io participated in them. To express their thoughts in fitting rms your Committee respectfully submit the following preamble d resolutions:

WHEREAS, In these annual meetings of the Association there is by the terchange of ideas a great good accomplished; and,

WHEREAS, These meetings, apart from their utility to the country and a

means of encouraging pleasant relations among those whose interests are in common; and,

WHEREAS, We can see the advantages to be gained from these social reunions in the places visited; therefore,

Resolved, That the sincere thanks of this Convention be returned to the citizens of Baltimore, through Mr. G. H. Hunt and his associates of the Executive Committee; and to Mr. Wm. Ried and his associates of the Reception Committee, for their courteous hospitality.

Resolved, That we tender our sincere thanks to the officers of the various railroads who have kindly extended favors to the Association, among whom are the Baltimore, Potomac & Northern Central Railroad, Philadelphia, Wilmington & Baltimore, Baltimore & Ohio, Pennsylvania Central, and to many others who have favored us with facilities for coming to this Convention and in returning to our homes.

Resolved, That the thanks of this Association are eminently due and are hereby sincerely tendered to the Press of Baltimore for the very flattering attentions paid to us by the full reports given of our proceedings.

Resolved, That we remember with pleasure the many kind attentions paid to the ladies accompanying the members of the Association by the committees in charge, and tender to them in their behalf our sincere thanks.

All of which is respectfully submitted,

COLEMAN SELLERS, *Philadelphia*,
FRED. C. LOSEY, *Jackson*, *Michigan*,
THOS. W. PEEPLES, *Elizabethport*, *N. J.*

On motion, the report was received and adopted.

A vote of thanks was also returned to Rev. Mr. Lightbourne for his attentions to the Convention.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—There is another matter that ought to be attended to now, and that is the compensation of the Secretary. I move that his compensation be the same as last year; I believe it was five hundred dollars.

The motion was carried.

PRESIDENT BRITTON—There is a matter which should come before the Convention at the present time, perhaps, and that is the subject of delinquent members. I am very sorry to say that, from the report of our Secretary to me at the opening of this Convention, it appears that we are something like five hundred dollars behind with delinquent members. I think some action should be taken at this Convention on that matter.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—There should be some effort made to collect these delinquent dues. Some change ought to be made in the by-laws by which any member in arrears more than

eighteen months may be suspended from all rights and privileges of the Association. I think the Association should take some action on the subject now, so that by the time we meet again these gentlemen who do not pay up in that time may be suspended.

SECRETARY SETCHEL—I will just say that at the close of the year, when the accounts between the Treasurer and Secretary were closed, the amount on the delinquent list was five hundred and two dollars. Since that time and since coming here I have received seventy dollars from delinquent members.

Mr. SPRAGUE, of Pittsburgh—In regard to myself, if I am included in that delinquent list, Mr. President, I will say that I joined the Association at Cleveland. The next year you met in Pittsburgh, when I was ineligible as a member from being a Locomotive Builder instead of a Master Mechanic. The next year you made a rule admitting Locomotive Builders. I was too busy to attend the Convention at Louisville, and my foreman ran away and left me in the lurch just as I was preparing to attend the Convention at Boston. Between the time you met in Cleveland and now I have not considered myself a member.

Mr. FRY, Grand Trunk Railroad—I move that Mr. Sprague be considered a member by paying the assessment due at this time.

The motion was carried.

Mr. FLYNN, Western & Atlanta Railroad—While waiting for the report of the Committee on Associate Members I would like to make a few remarks. I am sorry indeed to see so few Master Mechanics from my section of the country in this Convention. The reason there are not more of them here is, I think, because they do not fully understand the character and purposes of the Association. I think they have an erroneous idea of our Association. Some two years or longer ago a gentleman passed through our section of the country representing that he was authorized by the Association to visit the different Railroad Superintendents, and consult with the Master Mechanics with a view to getting them to join the Association. What I disliked about the person was that, after he got through with that kind of talk, he wanted to sell me some goods. I will be frank and admit that I knew very little about the Association at that time, and I could not see, if he was sent by the Association, that he should try to sell goods at the same time. The same person probably went to a number of Master Mechanics in the South in just the same way, and I can assure you if he did he left a very bad impression. What I suggest is that I do not think it would be improper for the Supervisory Committee to address a letter to the various Railroad Superintendents and Presidents in the South, requesting that they be kind enough to send their Master Mechanics to the Convention at Chicago. They would then see exactly what we are doing, and I have no doubt in a year or two we should

have quite a large Southern membership. With this view I have drawn up this resolution:

Resolved, That a committee of four be appointed, consisting of the President, First and Second Vice-Presidents, and Secretary, whose duty it shall be to address the Presidents or Superintendents of the roads not represented in this Convention, inviting them to send the Master Mechanics of their respective roads to our next annual meeting.

JOHN H. FLYNN.

THE PRESIDENT—Would you not be willing to have it read: "All roads that do not send representatives to the conventions of the Association?"

Mr. FLYNN, Western & Atlanta Railroad—Certainly; I accept the amendment.

On motion of Mr. Sprague the resolution was adopted.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—In reference to this matter of dues, Mr. President, I propose an amendment to the Constitution. It is to Article IV, Section 4, which I propose shall read: "All members who shall be two years in arrears for annual dues shall have their names stricken from the roll, and be duly notified by the Secretary of the same."

The amendment was adopted.

Mr. J. O. D. Lilly, of Indianapolis, offered the following:

To the American Railway Master Mechanics' Association:

GENTLEMEN—In conversation with a number of the members of your Honorable Body it seems to be the desire to institute a bureau for the purpose of placing Master Mechanics (members of this Association), who may be out of employment and desiring situations, in connection with railroad companies needing Master Mechanics. If desirable and agreeable to your Honorable Body the undersigned tenders his services and use of his offices, 47 Dey Street, New York. and Indianapolis, Indiana, and further proposes to defray all expenses connected therewith, to-wit: stationery, printing, postage, etc.

Very respectfully yours,

J. O. D. LILLY.

On motion of Mr. Elliott, of the Ohio & Mississippi Railroad, the paper was laid on the table.

The Committee to whom was referred the three applications for membership presented the following report:

Report of Committee on Associate Membership.

To the American Railway Master Mechanics' Association:

GENTLEMEN—Your Committee, after careful consideration, would recommend the following names as Associate Members:

L. D. Bartlett, of Fitchburgh, Massachusetts, and Edwin Harrington, Philadelphia.

ROBERT CURTIS,
J. W. PHILBRICK, *Committee.*
J. I. KINSEY,

The President appointed Messrs. Young, of the Cleveland, Columbus, Cincinnati & Indianapolis Railroad, and Henry Elliott, of the Ohio & Mississippi Railroad, as tellers to receive the votes.

Mr. WELLS, Jeffersonville, Madison & Indianapolis Railroad—Before we are called upon to vote on either application some of us would like to know something in regard to these persons as Associate Members—whether they are just such members as would be useful to us. If they are not going to be useful members, such as may be able to give us valuable information, I for one would not be in favor of admitting them. We have only a few vacancies left, and we want them filled by intelligent, inquiring, scientific, and practical men. Personally these might be the best of men, and I presume they are; yet unless they are practical men, capable of assisting us in our investigations, I do not think they would be very valuable acquisitions. We would like to know something about their capacity in that way.

Mr. SPRAGUE, of Pittsburgh—I move the question be laid over until the next meeting.

Mr. FLYNN, Western & Atlanta Railroad—I should suppose from the character of the Committee appointed on this subject, and from their long absence from the room, that they have made searching inquiries in regard to the qualifications of the applicants for admission into our Association as Associate Members. Knowing the men on that Committee I do not think they would recommend anybody except such persons as would be proper members of the Association. If we were to lay the report over now, it might seem like treating the Committee with some disrespect.

Mr. WOODCOCK, Central Railroad of New Jersey—In regard to one of the gentlemen, Mr. Harrington, I have spoken to several members of the Association about him, and they have all spoken of him as a good, practical man.

Mr. Fry, Grand Trunk Railroad—I would suggest to Mr. Woodcock that we do not want practical men as Associate Members so much as men of strength in scientific attainments.

Mr. Sprague's motion was carried.

Mr. Setchel, Little Miami Railroad—I would like to inquire, Mr. President, whether the amendment just made to the Constitution in regard to delinquent members is intended to effect those members who are already in arrears?

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—My intention was that it should apply to all. Of course I intended that the delinquents should be notified in time to pay up.

Mr. Setchel, Little Miami Railroad—Then, after I notify those members who are already two years behind in their dues, and do not pay up before the printing of the annual report, I am to drop their names from our list.

Mr. Wells, Jeffersonville, Madison & Indianapolis Railroad—If it can be done I would extend the time until the next annual meeting.

Mr. Lilly, of Indianapolis—I think slips should be printed by the Secretary and sent to the members who are delinquent, containing the article of the Constitution as it now stands in reference to delinquents, and, after giving them reasonable time, if they do not pay drop their names from the list.

Mr. Flynn, Western & Atlanta Railroad—I would suggest that when the Secretary notifies the members of their delinquency he also send them the amendment to the Constitution, and call their attention to it. Then, if they do not pay their dues and arrearages, their names could and ought to be dropped from our rolls altogether. They ought all, however, to have ample warning of the action of the Association as to delinquent members.

Mr. Setchel, Little Miami Railroad—After the adoption of the resolution at the Louisville Convention, instructing the Secretary to report all delinquents at the next annual meeting, I wrote each delinquent member a personal letter reminding them of that action of the Association. When they did not respond I wrote to them again, and in some cases two or three letters would pass between us in regard to the remaining dues. Finally, just previous to this meeting, I wrote again to those still in arrears asking what disposition they desired made of their names. Some replied that they would be here and pay their dues; others made responses not quite so satisfactory, and in one case not quite so courteous. They have all had ample warning, and it seems to me that after a proper notification to them now, under the amendment to the Constitution, their names should be dropped from the list.

Mr. Robinson, Great Western Railroad—In order that there may be no misunderstanding in regard to the matter of Associate Memberships, I would call the attention of the Convention to Section 2 of Article IV of our Constitution, which says: "Civil and Mechanical Engineers, and others whose qualifications and experience might be valuable to the Association, may

become Associate Members of the Association," etc. Now if we bear in mind that there are only eight places left, and we propose three additions to our list every year, in a few years we would have no places left. I think we should be very careful and very select in our choice. Mr. Towne, I understand, was going to propose a gentleman whose scientific attainments would have been of great value to the Association; and there will be other persons coming up from time to time whose knowledge will be useful to us in our investigations. If we go on filling up our vacancies with persons who simply desire to belong to the Association, and are not likely to give us any scientific aid whatever, the Association will lose the services of such gentlemen as I have referred to, as there will be no places to give them. I have been asked two or three times by gentlemen to get them recommended for admission to the Association. I have found that their reasons for desiring admission came from selfish interests and from no desire for the general good of the Association, therefore I would not think of recommending them for a moment. I think members should bear that in mind and be very careful and considerate in bringing candidates for Associate Memberships forward. I would also like to mention that the last time we met together a great deal was said about the value and desirability of bringing drawings and models of anything new that members may have come in contact with during the past year. It seems to me that members might bring from two to three drawings, or something of that kind, that might be hung up on the walls instead of the familiar mechanical photographs such as we have here. If we were to do that, instead of bringing the new things altogether in our brains, we could bring them in a shape in which they could be seen and fully explained.

Mr. COLEMAN SELLERS, of Philadelphia—It has been noticed by me with a good deal of satisfaction, the commendable manner in which our President has performed his duties, and the care with which our Secretary has attended to his. It is but due to those officers that a vote of thanks be tendered to them for their efficient care for the concerns of the Association. I therefore offer a resolution of thanks to the President, Secretary, and other officers of the Association for their services.

The motion was put to the Convention by Vice-President Chapman and carried.

PRESIDENT BRITTON—I wish to return to the members my thanks for their kindness to myself during this Convention, and for the attention they have paid to business.

On motion of Mr. Elliott, of the Ohio & Mississippi Railroad, the Convention adjourned.

COMMITTEES AND SUBJECTS FOR DISCUSSION AT THE SEVENTH ANNUAL CONVENTION.

1.

The Operation and Management of Locomotive Boilers, Including the Purification of Water.

H. A. TOWNE, Hannibal & St. Joseph;
A. H. DeCLERCQ, Toledo, Peoria & Warsaw;
H. ELLIOTT, Ohio & Mississippi;
COLEMAN SELLERS, Philadelphia;
T. W. PEEPLES, Central, of New Jersey.

2.

Fuel for Locomotives.

The Committee to report on the actual consumption, per ton, of load per mile run, of each kind of fuel used, and also the best form and proportion of fire-box, and the proper proportion of tube surface to grate surface requisite to produce the best results in the consumption of coal.

CHARLES GRAHAM, Lackawanna & Bloomsburg;
L. S. YOUNG, Cleveland, Columbus, Cincinnati & Indianapolis;
B. H. KIDDER, Atlantic & Great Western.

3.

The Best Form of Safety Valve, or Method of Relieving Boilers of Overpressure, and the Best Way of Testing Pressure Gauges.

C. R. PEDDLE, St. Louis, Vandalia, Terre Haute & Indiana;
W. F. RAY, Toledo, Wabash & Western;
S. KEELER, Flint & Pere Marquette.

4.

Boiler Explosions.

Committee appointed to attend the experiments to be made by the Government in regard to boiler explosions, to report to the American Railway Master Mechanics' Association.

Committee to attend experiments to be made at Sandy Hook:

H. M. BRITTON, Whitewater Valley, Cincinnati;
A. B. UNDERHILL, Boston & Albany, Boston, Mass.;
H. L. BROWN, Erie, Jersey City, New Jersey;
J. H. FLYNN, Western & Atlantic, Atlanta, Georgia;
THOMAS KERR, Camden & Amboy, Bordentown, New Jersey;
W. A. ROBINSON, Great Western, Hamilton, Canada.

Committee to attend experiments to be made at Cincinnati or Pittsburgh:

H. M. BRITTON, Whitewater Valley;
R. WELLS, Jeffersonville, Madison & Indianapolis;
J. R. PEDDLE, St. Louis, Vandalia & Terre Haute;
J. H. SETCHEL, Little Miami;
S. M. CUMMINGS, Pittsburgh, Ft. Wayne & Chicago;
N. E. CHAPMAN, Cleveland & Pittsburgh.

5.

Valves and Valve Gearing.

The Committee to report on the merits of the balance valve as compared with the ordinary valve, and upon the relative value of large and small ports, and out and inside lap.

J. I. KINSEY, Lehigh Valley;
J. THOMPSON, Eastern Railroad;
G. H. TIER, Lake Shore & Mich. Southern.

6.

Locomotive Tires.

The Committee to report on thickness, when put in and when taken out of service; the number of times turned during the time; the total number of miles run; the size and weight carried on each wheel; the kind of service and the maker's name.

J. N. LAUDER, Northern Railroad;
F. A. WAITE, Boston & Maine;
ALBERT GRIGGS, Worcester & Nashua.

7.

Standard Axles.

Committee to report on a standard driving truck and tender axle for a given size and weight of engine, and the same for passenger and freight cars.

M. N. FORNEY, Railroad Gazette;
COLEMAN SELLERS, Philadelphia;
GORDON H. NOTT, Boston.

8.

Continuous Train Brakes.

R. WELLS, Jeffersonville, Madison & Indianapolis;
L. H. WAUGH, Kansas Pacific;
E. B. GIBBS, Louisville, Cincinnati & Lexington.

9.

Oils for Locomotive Use.

Committee to report on the best lubricant for cylinders and other machinery of locomotives, giving number of miles run per quart of each special kind.

WM. STEARNS, Connecticut;
J. JOHANN, Chicago & Canada Southern;
W. BELL SMITH, South Carolina.

10.

Machinery for Supplying Water to Tanks, Giving Description of Engine, Windmill, or device, with Cost of Working the same.

J. L. WHITE, Evansville & Crawfordsville;
J. H. FLYNN, Western & Atlantic;
H. FRY, Grand Trunk.

11.

Narrow and Broad Gauge Rolling Stock.

Committee to report on the actual weight of each class; the gross ton that engines of a given weight and size in general use can haul, and the actual loads that freight cars carry; also, the amount dead weight carried per ton of paying weight in each case.

W. S. HUDSON, Roger's Locomotive Works;
J. A. DURGIN, Pittsburgh Locomotive Works;
H. N. SPRAGUE, Locomotive Builder, of Pittsburgh.

12.

Mechanical Laboratory.

Committee to take into consideration the propriety of establishing a Mechanical Laboratory, also to ascertain the cost of a Dynamometer for the purpose of ascertaining the resistance of trains on straight and curved tracks.

W. A. ROBINSON, Great Western;
R. WELLS, Jeffersonville, Madison & Indianapolis;
J. M. BOONE, Pittsburgh, Ft. Wayne & Chicago;
N. E. CHAPMAN, Cleveland & Pittsburgh;
H. M. BRITTON, Whitewater Valley.

13.

Finance.

E. GARFIELD, Hartford, Providence & Fishkill;
THOMAS KERR, Camden & Amboy;
WM. McALLISTER, West Jersey.

14.

Trustees of Boston Fund.

H. M. BRITTON, Whitewater Valley;
N. E. CHAPMAN, Cleveland & Pittsburgh;
W. A. ROBINSON, Great Western, of Canada;
J. H. SETCHEL, Little Miami.

15.

Printing.

H. M. BRITTON, Whitewater Valley;
N. E. CHAPMAN, Cleveland & Pittsburgh;
W. A. ROBINSON, Great Western, of Canada;
J. H. SETCHEL, Little Miami.

16.

General Supervisory.

H. M. BRITTON, Whitewater Valley;
N. E. CHAPMAN, Cleveland & Pittsburgh;
W. A. ROBINSON, Great Western, of Canada
J. H. SETCHEL, Little Miami.

CONSTITUTION AS AMENDED AT SIXTH ANNUAL MEETING, BALTIMORE, MAY 13, 1873.

PREAMBLE.

WE, the undersigned, Railway Master Mechanics believe that the interests of the Companies by whom we are employed may be advanced by the organization of an Association which shall enable us to exchange information upon the many important questions connected with our business. To this end do we establish the following

CONSTITUTION.

ARTICLE I.

SECTION 1. The name and style of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

SEC. 1. The officers of the Association shall be a President, a First and Second Vice-President, a Secretary, and a Treasurer.

SEC. 2. The above-named officers shall be elected separately, by ballot, at a regular meeting, and a majority of all votes cast shall be necessary to a choice.

SEC. 3. The officers shall be elected for a term of one year, but in the event of the election being postponed shall continue in office until their successors shall be elected.

SEC. 4. Two tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE III.

SEC. 1. It shall be the duty of the President to preside in the usual manner at all the meetings of the Association, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members of the Association, and the name of the road they each represent; to receive and keep an account of all money paid to the Association, and at the close of each meeting deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills against the Association, and pay the same, after having the approval of the President; to deliver all paid bills to the Secretary at the close of each meeting, taking a receipted statement of the same; to keep an accurate book account of all transactions pertaining to his office.

ARTICLE IV.

SEC. 1. The following persons may become members of the Association by signing the Constitution, or authorizing the President or Secretary of the Association to sign for them, and pay the initiation fee of one dollar: Any person having charge of the Mechanical Department of a Railway known as "Superintendents," or "Master Mechanics," or "General Foremen," the names of the latter being presented by their superior officers for membership.

SEC. 2. Civil and Mechanical Engineers and others whose qualifications and experience might be valuable to the Association may become Associate Members by being recommended by three active members. Their names shall then be referred to a committee, which shall report to the Association on their fitness for such membership. Applicants to be elected by ballot at any regular meeting of the Association, and five dissenting votes shall reject. The number of Associate Members shall not exceed twenty. Associate Members shall be entitled to all the privileges of active members excepting that of voting. Also, two Mechanical Engineers or the representative of each Locomotive Establishment in America.

SEC. 3. Any person who has been or may be duly qualified, and signs, or causes to be signed, the Constitution, as member of the Association, remains as such until his resignation may be voluntarily tendered.

SEC. 4. All members of the Association will be liable for such dues as may be necessary to assess to defray the expenses of the Association, and any

member who shall be two years in arrears for annual dues shall have his name stricken from the roll, and be duly notified of the same by the Secretary.

ARTICLE V.

SEC. 1. The regular meeting of the Association shall be held annually on the second Tuesday in May.

SEC. 2. Regular meetings shall be held at such place as may be determined upon by a majority of the members present at the previous meeting.

SEC. 3. An adjourned meeting may be held at any time and place that a majority of the members present at any meeting may elect.

SEC. 4. The regular hours of sessions shall be from 9 o'clock, A. M., to 2 o'clock, P. M.

SEC. 5. During the business sessions no communications shall be received or acted upon other than those pertaining to the business of the Association.

ARTICLE VI.

SEC. 1. This Constitution may be amended at any regular meeting of the Association by two-thirds vote of the members present.

Resolution passed at the Sixth Annual Meeting, Baltimore, May, 1873.

Resolved, That no expense shall be incurred by committees except by the unanimous consent of the General Supervisory Committee, given in writing to the chairmen of said committees stating the amount to be expended.

NAMES AND ADDRESS OF MEMBERS OF AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

NAME.	ROAD.	ADDRESS.
Anderson H.		36 South Canal St., Chicago, Ill.
Anderson, J. H.	N. Y. B. & P. R. R.	Providence, R. I.
Adams, Ralph	B. C. & M. R. R.	Lake Village, N. H.
Adams, G. Q.	M. I. & W. R. R.	Alexandria, Mo.
Alden, H. A.	C. & P. R. R.	Lyndon, Vermont.
Britton, H. M.	W. W. V. R. R.	Cincinnati, Ohio.
Britton, A. W.	W. W. V. R. R.	Harrison, Ohio.
Brown, F. A.	D. L. & W. R. R.	Ithaca, N. Y.
Brown, M. E.	Erie R. R.	New York City.
Brown, H. L.	Erie R. R.	Jersey City, N. J.
Brown, C. H.	West. Div. D. L. & W. R. R.	Utica, N. Y.
Beattie, J. G.	S. M. & N. R. R.	Sandusky, Ohio.
Boone, J. M.	P. Ft. W. & C. R. R.	Fort Wayne, Ind.
Baer, R. B.	T. & N. O. R. R.	Houston, Texas.
Brear, M.	F. & N. S. R. R.	Flushing, N. Y.
Burke, M.	M. & T. R. R.	Memphis, Tenn.
Butterfield, J. G.	St. P. & S. C. R. R.	Shacopee, Minn.
Bushnell, R. W.	B. C. R. & M. R. R.	Cedar Rapids, Iowa.
Brastow, L. C.	L. & S. R. R.	Wilkesbarre, Pa.
Bryant, Wm. H.	Ft. W. & C. R. R.	103 Jud St., Chicago, Ill.
Bissett, F. A.	M. & L. R. R.	Memphis, Tenn.
Blackall, R. C.	A. & S. R. R.	Albany, N. Y.
Burroughs, A. P.	M. & O. R. R.	Marquette, Mich.
Boyden, G. E.	B. H. & E. R. R.	Boston, Mass.
Brooks, H. G.	Brooks' Locomotive Works	Dunkirk, N. Y.
Blanchard, J. M.	S. & R. R. R.	
Cullen, Wm.	C. H. & D. R. R.	Cincinnati, Ohio.
Cooper, W. E.	Erie R. R.	Hornersville, N. Y.
Chapman, N. E.	C. & P. R. R.	Cleveland, Ohio.
Cummings, S. M.	P. Ft. W. & C. R. R.	Allegheny, Pa.
Coolidge, G. A.	F. R. R.	Charlestown, Mass.
Cushing, G. W.	T. P. & W. R. R.	St. Paul, Minn.
Connell, Thos.	B. C. & P. R. R.	Mayville, N. Y.
Clark, D.	L. V. R. R.	Hazleton, Pa.

NAME.	ROAD.	ADDRESS.
Clark, Peter	N. R. R. of C	Toronto, Canada.
Church, F.	T. & B. R. R.	Troy, N. Y,
Collings, E	C. & A. R. R.	Camden, N. J.
Colburn, R.	N. & W. R. R.	Norwich, Conn.
Calhoun, J. C.	St. L. K. C. & N. R. R.	Kansas City, Mo.
Cook, James	Danforth & Cook's Locomotive and Manufacturing Co	Paterson, N. J.
Curtis, Robert	P. C. & St. L. R. R.	Columbus, Ohio.
Crocket, John F.	B. L. & N. R. R.	Boston, Mass.
DeClercq, A. H.	T. P. & W. R. R.	Peoria, Ill.
Devine, J. T.	W. & W. R. R.	Wilmington, N. C.
Durgin, J. A	Pittsburgh Locomotive Works	Pittsburgh, Pa.
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Davies, D. T.	V. & M. R. R.	Fitchburg, Mass.
Duncan, W	B. B. & G. R. R.	Worcester, Mass.
Dohoney, R. V.	W. M. R. R.	Westminster, Md.
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Eastman, C. L.	C. R. R.	Concord, N. H.
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Foster, W. L.	P. & E. R. R.	Renovo, Pa.
Fry, Howard	Erie R. R.	Susquehanna, Pa.
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Griggs, Albert	W. & N. R. R.	Worcester, Mass.
Granger, W. E.	W. & B. R. R. R.	Utica, N. Y.
Gassett, L. O	L. S. & M. S. R. R.	South Cleveland, Ohio.
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Gould, F.	M. K. & T. R. R.	Sedalia, Mo.
Glynn, Richard		182 Michigan Avenue, Detroit, Mich.
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Hofecker, P.	L. V. R. R.	Weatherby, Pa.
Hudson, W. S.	Rogers' Locomotive Works	Paterson, N. J.
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Hewitt, John	A. & P. R. R	Pacific, Mo.
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Haynes, O. A	St. L. & I. M. R. R.	Carondelet, Mo.
Healy, B. W.	Rhode Island Loco'tive Works	Providence, R. I.
Hollister, C. W	Valley R. R.	Hartford, Conn.
Hubbard, J. G.	Erie R. R.	Buffalo, N. Y.
Hanford, Henry	Naugatuck R. R.	Bridgeport, Conn.
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Kerr, Thos.	C. & A. R. R	Bordentown, N. J.

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Little, H. A		2,043 Tower St., Philadelphia, Pa.
Little, O. H. P.		Indianapolis, Ind.
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Losee, T. N	P. C. & St. L. R. R.	Indianapolis, Ind.
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Lewis, W. H	Morris & Essex Div. D. L. & W. R. R.	Hoboken, N. J.
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Moore, S	P. Ft. W. & C. R. R	Allegheny, Pa.
Meier, E. D		26 North Main Street, St. Louis, Mo.
Mulligan, J	C. R. R. R.	Springfield, Mass.
Messer, J. P	B. C. R. & M. R. R.	Cedar Rapids, Iowa.
Mullen, James	M. & B. R. R	Mulligan, Ga.
Mullen, James, Jr	W. & A. R. R.	Atlanta, Ga.
Mitchell, A.	L. V. R. R.	Mauch Chunk, Pa.
Montgomery, Jas.	L. & N. R. R	Bowling Green, Ky.
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Philbrick, J. W	M. C. R. R	Waterville, Maine.
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Prescott, G. H	P. C. & St. L. R. R	Logansport, Ind.
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Smith, W. T	P. & E. R. R	Erie, Pa.
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Smith, J. Y	Locomotive Builder	Pittsburgh, Pa.
Sellers, Morris	Air Brake Company	Pittsburgh, Pa.
Sellers, L. H	N. O. J. & G. N. R. R	New Orleans, La.
Setchel, J. H	L. M. R. R	Cincinnati, Ohio.
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Sedgley, J	L. S. & M. S. R. R	Cleveland, Ohio.
Street, C. B	Pennsylvania R. R	Blairsville, Pa.

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Slingland, N	Western R. R	Hartford, Conn.
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Towne, L. N	H. & St. Jo. R. R	Hannibal, Mo.
Tier, G. H	Toledo Div., L. S. & M. S. R. R.	Norwalk, Ohio.
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Van Vetchen, J	A. & G. W. R. R	Meadville, Pa.
Van Tuyl, A		Urbana, Champaigne Co., Illinois.
Van Buskirk	D. & C. R. R	Fishkill, N. Y.
Wells, Reuben	J. M. & I. R. R	Jeffersonville, Ind.
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Waite, F. A	B. & M. R. R	Boston, Mass.
Woodcock, W	Central R. R	Elizabethport, N. J.
White, J. L	E. & C. R. R	Evansville, Ind.
Waddy, J. E	O. A. & M. R. R	Alexandria, Va.
Williams, E. H	Baird & Co., Loco. Builders	Philadelphia, Pa.

NAME.	ROAD.	ADDRESS.
Wooten, J. E	P. & R. R. R	Reading, Pa.
Waugh, L. H	K. P. R. R	Wyandotte, Kansas.
Weaver, D. S	E. K. R. R	Riverton, Ky.
Whitworth, John	L. S. N. & P. R. R	Norfolk, Va.
Wood, M. P	C. & T. H. R. R	Cincinnati, Ohio.
Wall, Martin	P. & E. R. R	Sunbury, Pa.
Young, L. S	C. C. C. & I. R. R	Cleveland, Ohio.

ASSOCIATE MEMBERS.

Bement, W. B	21st and Callowhill Streets, Philadelphia, Pa.
Evans, W. W	45 & 47 Exchange Place, New York.
Forney, M. N	Railway Gazette, 73 Broadway, New York.
Holly, A. F	Troy, New York.
Lilly, J. O. D	Indianapolis, Indiana.
Miles, F. B	Ferris & Miles, Philadelphia, Pa.
Morten, Henry	Hoboken, New Jersey.
Nott, Gordon H	Boston, Massachusetts.
Sellers, Coleman	Philadelphia, Pennsylvania.
Thurston, R. H	Hoboken, New Jersey.
Wheelock, Jerome	Worcester, Massachusetts.

ORDER OF BUSINESS.

1. Reading the Minutes of previous meeting.
2. Calling the Roll of Members.
3. Signing the Constitution.
4. Report of Treasurer.
5. Report of Committees appointed at a previous meeting.
6. Election of Officers.
7. Appointment of a Committee to suggest Subjects for Consideration.
8. Appointment of Miscellaneous Committees: on Finance, Printing, place for next Annual Meeting.
9. Report of Committee to suggest Subjects for Consideration.
10. Appointment of Committees to report upon the Subjects suggested for Consideration.
11. Unfinished Business.

(Signed,)

H. M. BRITTON,
N. E. CHAPMAN,
WM. A. ROBINSON,
J. H. SETCHEL,
} *Committee.*

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